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NX FREQUENCY CONVERTERS

POSITION CONTROL APPLICATION APFIFF12

USER'S MANUAL

ABOUT THE POSITION CONTROL APPLICATION MANUAL

Congratulations for choosing the Smooth Control provided by Vacon NX Frequency Converters!

This manual is available in both paper and electronic editions. We recommend you to use the electronic version if possible. If you have the **electronic version** at your disposal you will be able to benefit from the following features:

The manual contains several links and cross-references to other locations in the manual which makes it easier for the reader to move around, to check and find things faster.

The manual also contains hyperlinks to web pages. To visit these web pages through the links you must have an internet browser installed on your computer.

VACON POSITION CONTROL APPLICATION MANUAL

INDEX

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1. Introduction 5
1.1 Requirements 5
1.2 Other documentation 6
2. Commissioning notes 7
2.1 Application selection through the control keypad 7
2.2 Preliminary checking 7
2.3 Position control settings 7
2.3.1 Control I/O 7
3. "Terminal To Function" (TTF) programming principle 8
3.1 Defining an input/output for a certain function on keypad 8
3.2 Defining a terminal for a certain function with NCDrive programming tool 9
3.3 Defining unused inputs/outputs 9
4. Control I/O 10
5. Parameter lists 11
5.1 Monitoring values (Control keypad: menu M1) 12
5.2 Basic parameters (Control keypad: Menu M2 → G2.1) 13
5.3 Input signals 14
5.3.1 Basic settings (Control keypad: menu M2 → G2.2.1) 14
5.3.2 Analogue input 1 (Control keypad: Menu M2 → G2.2.2) 15
5.3.3 Analogue input 2 (Control keypad: Menu M2 → G2.2.3) 15
5.3.4 Free analogue input signal (Control keypad: Menu M2 → G2.2.4) 16
5.3.5 Digital inputs (Control keypad: Menu M2 → G2.2.5) 17
5.4 Output signals 18
5.4.1 Delayed digital output 1 (Keypad: Menu M2 → G2.3.1) 18
5.4.2 Delayed digital output 2 (Keypad: Menu → G2.3.2) 18
5.4.3 Digital output signals (Control keypad: Menu M2 → G2.3.3) 19
5.4.4 Limit settings (Control keypad: Menu M2 → G2.3.4) 20
5.4.5 Analogue output 1 (Control keypad: Menu M2 → G2.3.5) 21
5.5 Drive control (Control keypad: Menu M2 → G2.4) 22
5.6 Motor control parameters (Control keypad: Menu M2 → G2.5) 23
5.6.1 Closed loop (Control keypad: Menu M2 → G2.5.13) 24
5.6.2 PMSM settings (Control keypad: Menu M2 → G2.5.15) 24
5.7 Protections (Control Keypad: Menu M2 → G2.6) 25
5.8 Autorestart parameters (Control keypad: Menu M2 → G2.7) 25
5.9 Position control parameters (Control keypad: Menu M2 → G2.8) 26
5.9.1 Advanced functions (Control keypad: Menu M2 → G2.8.7) 27
5.9.2 Calibration/home parameters (Control keypad: Menu M2 → G2.8.8) 28
5.9.3 Jog parameters (Control keypad: Menu M2 → G2.8.9) 28
5.9.4 Positions parameters (Control keypad: Menu M2 → G2.8.10) 29
5.9.5 Automatic cycle parameters (Control Keypad: Menu M2 → G2.8.11) 30
5.10 Fieldbus parameters (Control keypad: Menu M2 → G2.9) 32
5.11 SystemBus parameters (Control keypad: Menu M2 → G2.10) 33

5.11.1 Master (Control keypad: Menu → G2.10.2) 33
5.11.2 Follower (Control keypad: Menu → G2.10.3) 33
5.12 Keypad control (Control keypad: Menu M3) 34
5.13 Jog teach 34
5.14 System menu (Control keypad: Menu M6) 34
5.15 Expander boards (Control board: Menu M7) 34

6. Functional description 35

6.1 Generical functions and speed regulation 35
6.2 Position control 35
6.2.1 PosControllerEn 35
6.2.2 The control sequencer: commands 35
6.2.3 The control sequencer: inputs 42
6.2.4 The command sequencer: limit switch handling 45
6.2.5 User unit definition and dimensioning considerations 45
6.2.6 The command sequencer: "mission" supervision 48
6.2.7 The command sequencer: Fieldbus interface 49
6.2.8 The command sequencer: Calibration mode 52
6.2.9 The regulator 56
6.2.10 Special function: Automatic cycle 57
6.3 Fieldbus configuration 59
6.4 SystemBus configuration 61

7. Description of standard parameters 62

8. Keypad control parameters 97

9. Appendices 98

9.1 Closed loop parameters (ID's 612 to 621) 100
9.2 Advanced Open Loop parameters (ID's 622 to 625, 632, 635) 100
9.3 Parameters of motor thermal protection (ID's 704 to 708): 101
9.4 Parameters of Stall protection (ID's 709 to 712): 101
9.5 Parameters of Underload protection (ID's 713 to 716): 102
9.6 Fieldbus control parameters (ID's 850 to 859) 102

10. DESCRIPTION OF PARAMETERS SPECIFIC for position control application 103

10.1 Digital inputs 103
10.2 Protections 105
10.3 Position control 106
10.4 Advanced functions 107
10.5 Calibration Home 108
10.6 Jog 109
10.7 Positions 110
10.8 Automatic cycle 111
10.9 Fieldbus 112
10.10 SystemBus 113
10.10.1 Master 113
10.10.2 Follower 113
10.11 Jog teach 113

11. Specific fault codes of Position Control Application 114

POSITION CONTROL APPLICATION (APFIFF12) V1.11 OR HIGHER

1. INTRODUCTION

The APFIFF12 application (Position Control Application) is designed to control an operating axis with these functions:

- single axis trapezoidal interpolator
- linear ramp
- programmable distance/turns in engineering unit makes it possible to work only with engineering units
- using of motor encoder or auxiliary encoder for the positioning loop
- 7 possible calibration modes (manual, Calibration sensor, Z-Pulse, with or without backlash compensation)
- positioning commands, jog, incremental jog, calibration, homing
- static and dynamic distance error supervision
- software limit stop (positioning range)
- hardware limit stop (min, max) by digital input control with alarm
- position control enable by parameter, digital input or by fieldbus (switching from speed control to position control and vice versa)
- jog and teach of positions from the keypad Jog Teach menu.
- preset positioning speed or adjustable speed by analogue input
- programmable automatic cycle up to 6 targets, with programmable dwell time and trigger
- support of either induction motor or permanent magnet synchronous motor (AC brushless)

Control interface:

- I/O terminals
- Profibus DP, CANOpen , Modbus or Modbus/TCP fieldbus

When the position control is not enabled, the application implements a standard speed/torque control with several programmable functions as a subset of the Multipurpose application in the "All in One" package (open loop or closed loop motor control with torque/current limit adjust, analogue references configuration, programmable digital references, motor potentiometer,etc). System bus support is also available for speed reference synchronization in master/follower schemes.

1.1 Requirements

- NXP drive with standard I/O equipment (OPT-A1, OPT-A2 boards)
- Speed feedback board:
  - OPT-A4, OPT-A5 or OPT-A7 encoder board for induction motor
  - OPT-BC, OPT-BB board for AC brushless motor
- Optional OPT-B1 board for digital inputs expansion
- Optional fieldbus board
- Optional System Bus board OPT-D1 or OPT-D2.
- Asynchronous three-phase motor with incremental encoder or
- AC brushless motor with either resolver or Endat encoder
- Application free of charge from version 1.11 (earlier was license required)

1.2 Other documentation

For more general information about the frequency converter (installation, use, keypad interface, etc) see:

- "Vacon NX Frequency Converter User Manual", code UD00701.

For more information about the general function of speed regulation and software see:

- "Vacon NX Multipurpose Application", code UD00885.

This manual contains the parameter descriptions of the positioning function only. For all other parameter descriptions, see

- "Vacon NX Multipurpose Application", code UD00885.

For more information about the option boards see the respective user's manual.

NOTE! You can download the English and French product manuals with applicable safety, warning and caution information from www.vacon.com/downloads.

REMARQUE Vous pouvez télécharger les versions anglaise et française des manuels produit contenant l'ensemble des informations de sécurité, avertissements et mises en garde applicables sur le site www.vacon.com/downloads.

2. COMMISSIONING NOTES

2.1 Application selection through the control keypad

During commissioning, set the application PositionCtrl in M6 menu at the location S6.2 (see User's Manual UD00701, chapter 7, chapter 7.3.6.2 "Application Selection").

2.2 Preliminary checking

The general procedure of commissioning is described in chapters 6, 7 and 8 of the User's Manual (see chapter 0). In Position Control Application it is necessary to use the closed loop speed control. For settings and tuning of closed loop speed control see chapter 5.6.1 "Closed loop parameter group" in Multipurpose Application manual (see chapter 0).

2.3 Position control settings

1. Choose the encoder type used as position's feedback (P2.8.2).
2. Define the position unit using parameters P2.8.3 Distance and P2.8.4 Turns (see chapter 6.2.5).
3. If external encoder (Channel 2 on OPTA7 board) is used for position feedback it is necessary to also set parameters P2.8.7.11 Distance ext. encoder and P2.8.7.12 Turns ext. encoder. Use of external encoder requires also correct setting of parameters for motor encoder P2.8.3 and P2.8.4.
4. Define the calibration cycle that is to be used (see chapter 6.2.2.1)
5. Configure digital inputs for position control using parameters in the G2.2.5 group, for the setting see chapter 3.
6. Do normal Closed loop commissioning with position control disabled to check that drive works normally in closed loop speed control before trying to run in position control mode.
7. Enable the position control and start tests with slow speed

2.3.1 Control I/O

Configure the I/O commands using the parameters in group G2.2, for the setting see chapter 3.
For applications that provide for speed control/position control switching, and vice versa:

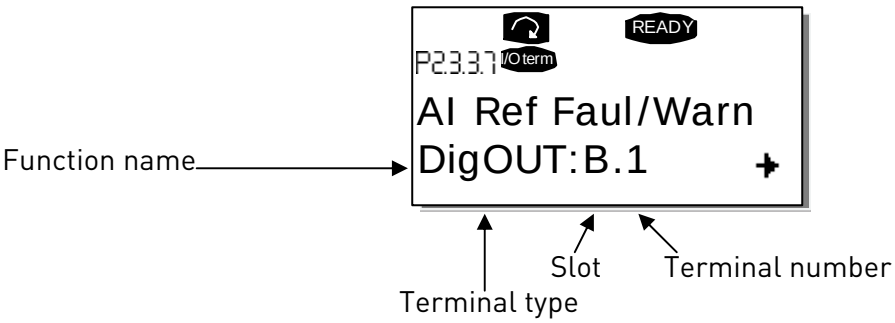
- if the control is selected by a digital input, set the position control enable input in P2.2.5.24
- if the control is selected by fieldbus, set P2.8.1 PosControllerEn = 2 "Enable by FB" and set the control by fieldbus in the Menu 3, P3.1 (see chapter 6.2.7)
- if the position control is always enabled set P2.8.1 PosControllerEn = 1 "enabled".

3. "TERMINAL TO FUNCTION" (TTF) PROGRAMMING PRINCIPLE

In the conventional programming method, *Function to Terminal Programming Method (FTT),* you have a fixed input or output that you define a certain function for. The applications mentioned above, however, use the *Terminal to Function Programming method (TTF)* in which the programming process is carried out the other way round: Functions appear as parameters which the operator defines a certain input/output for. See *Warning* in chapter 3.2.

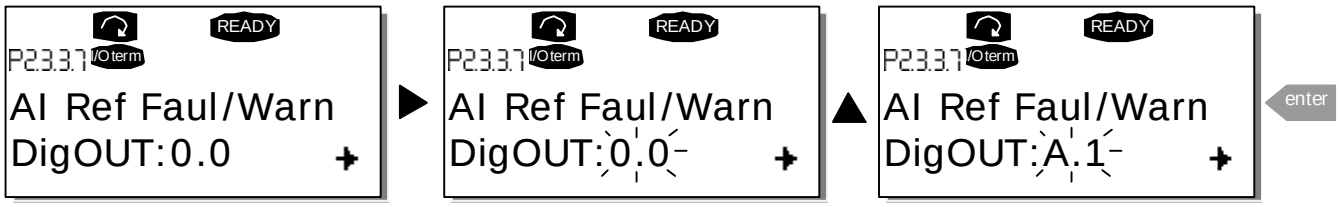
3.1 Defining an input/output for a certain function on keypad

Connecting a certain input or output with a certain function (parameter) is done by giving the parameter an appropriate value. The value is formed of the *Board slot* on the Vacon NX control board (see the product's User's Manual, Chapter 6.2) and the *respective signal number*, see below.



Example: You want to connect the digital output function *Reference fault/warning* (parameter 2.3.3.7) to the digital output DO1 on the basic board NXOPTA1 (see the product's User's Manual, Chapter 6.2).

First find the parameter 2.3.3.7 on the keypad. Press the *Menu button right* once to enter the edit mode. On the *value line*, you will see the terminal type on the left (DigIN, DigOUT, An.IN, An.OUT) and on the right, the present input/output the function is connected to (B.3, A.2 etc.), or if not connected, a value (0.#).
When the value is blinking, hold down the *Browser button up* or *down* to find the desired board slot and signal number. The program will scroll the board slots starting from **0** and proceeding from **A** to **E** and the I/O selection from **1** to **10**.
Once you have set the desired value, press the *Enter button* once to confirm the change.



3.2 Defining a terminal for a certain function with NCDrive programming tool

If you use the NCDrive Programming Tool to set drive parameters you will have to establish the connection between the function and input/output in the same way as with the control panel. Just pick the address code from the drop-down menu in the *Value* column (see the Figure below).

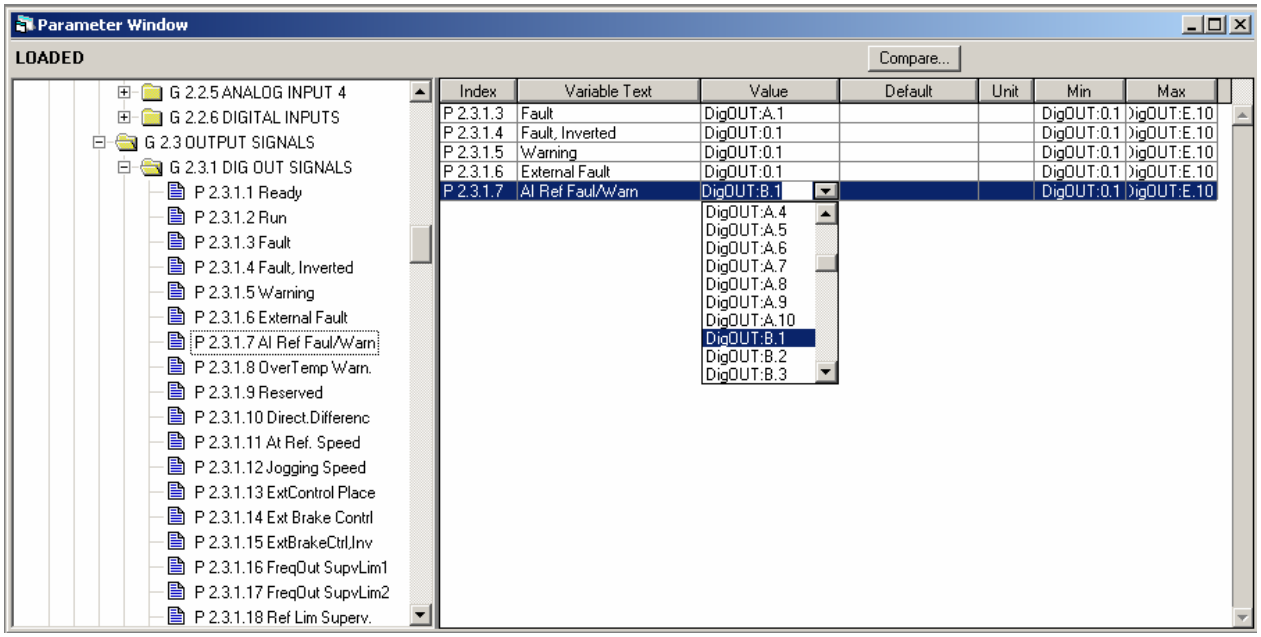


Figure 1. Screenshot of NCDrive programming tool; Entering the address code

WARNING	**Be ABSOLUTELY sure not to connect two functions to one and same output in order to avoid function overruns and to ensure flawless operation.**

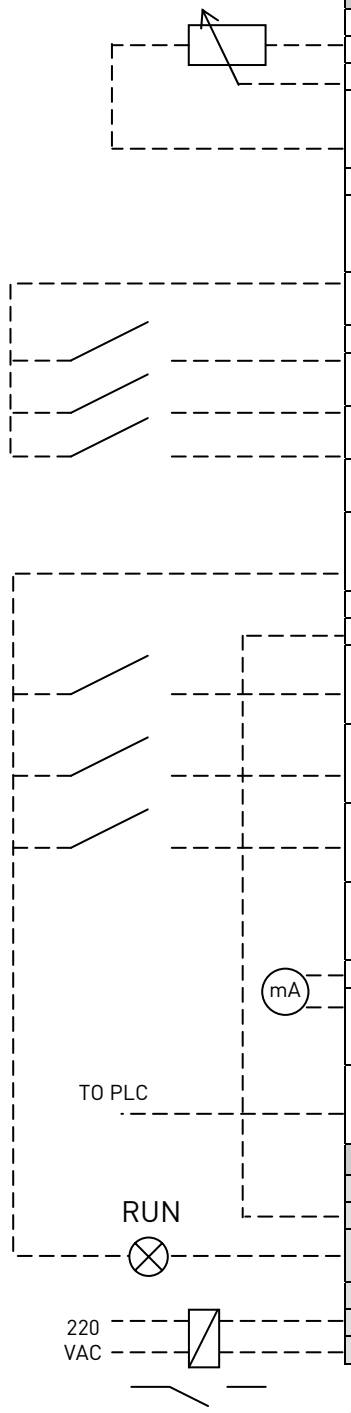
Note: Configuration of the *inputs*, unlike that of the *outputs*, cannot be changed in RUN state.

3.3 Defining unused inputs/outputs

All unused inputs and outputs must be given the board slot value **0** and the value **1** also for the terminal number. The value **0.0** is also the default value for most of the functions. However, if you want to use the **values of a digital input signal** for e.g. testing purposes only, you can set the board slot value to **0** and the terminal number to any number between 2...10 to place the input to a TRUE state. In other words, the value 1 corresponds to 'open contact' and values 2 to 10 to closed contact.

In case of analogue inputs, giving the value **1** for the terminal number corresponds to 0%, value **2** corresponds to 20% and any value between **3** and **10** corresponds to 100%.

4. CONTROL I/O



OPT-A1			
Terminal		Signal	Description
1	+10V$_{ref}$	Reference output, max 10 mA	Reference potentiometer, etc.
2	AI1+	Analogue input, voltage range 0—10V DC Voltage –10 .. + 10V DC Current 0/4 .. 20mA	Frequency reference for speed control (position control not used) - programmable
3	AI1-		
4	AI2+	Analogue input, voltage range 0—10V DC Voltage –10...+ 10V DC Current 0/4 ...20mA	Programmable input, not used
5	AI2-		
6	+24V	Control voltage output, max. 0.25 A	Voltage for switches, etc.
7	GND	I/O ground	Ground for references and controls
8	DIN1	Digital input 1	Run (programmable) Contact closed = Run
9	DIN2	Digital input 2	Jog forward (programmable) Contact closed = jog forward
10	DIN3	Digital input 3	Jog reverse (programmabile) Contact closed = jog reverse
11	CMA	Common for DIN 1—DIN 3	Connected to ground with X3 jumper, remove the jumper for external +24V voltage reference or with negative logic
12	+24V	Control voltage ouput	Voltage for switches (see #6)
13	GND	I/O ground	Ground for references and controls
14	DIN4	Digital input 4	(programmable)
15	DIN5	Digital input 5	(programmable)
16	DIN6	Digital input 6	Home (programmable) Contact closed = start Homing
17	CMB	Common for DIN4—DIN6	Connected to ground with X3 jumper, remove the jumper for external +24V voltage reference or with negative logic
18	AO1+	Analogue output, range Voltage 0 .. 10V DC, R_L> 1kohm Current 0/4 .. 20 mA, R_L < 500ohm	Output frequency (programmable)
19	AO1-		
20	DO1	Open collector digital output I≤50mA, U≤48 VDC	AXIS READY (programmable)
OPT-A2			
21	RO1	Relay output 1	Run (programmable)
22	RO1		
23	RO1		
24	RO2	Relay output 2	FAULT (programmable)
25	RO2		
26	RO2		

Table 1. Position Control Application default I/O configuration and connections.

5. PARAMETER LISTS

On the next pages you will find the lists of parameters within the respective parameter groups The parameter descriptions are given on chapter 6.

Column explanation:

Code	=	Location indication on the keypad; Shows the operator the present param. number
Parameter	=	Name of parameter
Min	=	Minimum value of parameter
Max	=	Maximum value of parameter
Unit	=	Unit of parameter value; given if available
default	=	value preset by factory
Cust	=	Customer's own setting
ID	=	Index number of the parameter (used with Pc tools, fieldbus, etc.)
	=	Parameter value can only be changed after the FC has been stopped
	=	Apply the Terminal to Function method (TTF) to these parameters (see chapter 3)

5.1 Monitoring values (Control keypad: menu M1)

The monitoring values are the actual values of the parameters and signals as well as statuses and measurements. Monitoring values cannot be edited.
See the product's User's Manual, Chapter 7 for more information.

Code	Value	Unit	ID	Description
V1.1	Output frequency		1	Output frequency to the motor
V1.2	Frequency reference		25	Frequency reference to motor control
V1.3	Motor speed	Rpm	2	Motor speed in rpm
V1.4	Motor current	A	3	Output current, rms
V1.5	Motor torque	%	4	In % of nominal motor torque
V1.6	Motor power	%	5	Motor shaft power, in % of motor nominal power
V1.7	Motor voltage	V	6	Voltage to the motor, rms
V1.8	DC link voltage	V	7	Voltage to the DC link
V1.9	Unit temperature	°C	8	Heatsink temperature
V1.10	Analogue input 1	V/mA	13	AI1
V1.11	Analogue input 2	V/mA	14	AI2
V1.12	DIN1, DIN2, DIN3		15	Digital input statuses
V1.13	DIN4, DIN5, DIN6		16	Digital input statuses
V1.14	Analogue output	mA	26	AO1
V1.15	ID Run Status		49	Status of ID run made
V1.16	Pole pair number		58	Calculated pole pair number based on given motor data
V1.17	PositLoopClosed		1500	Position control Enabled
V1.18	Axis moving		1501	Axis in movement
V1.19	Calibration OK		1502	Calibration done
V1.20	Positioning reference	U	1503	Position reference in axis-unit
V1.21	Actual position	U	1504	Actual position in axis-unit
V1.22	Positioning error	U	1505	Positioning error in axis-unit
V1.23	PosCtrlFreq Ref	Hz	1506	Frequency reference generated by position controller
V1.24	Encoder 1 Freq		1124	Encoder speed 1 in Hz, filtered by Enc1FiltTime
V1.25	Encoder 2 Freq		53	Encoder speed 2 in Hz
V1.26	Torque mode CL	%	1510	Torque generated in open loop control
V1.27	Torque ref. mode 3	%	1511	Torque ref. in closed loop speed control
V1.28	Torque ref. mode 4	%	1512	Torque ref. in closed loop torque control
FIELDBUS				
V1.30.1	Fault History		37	Last active fault
V1.30.2	DI Status A.1-A.6		1513	Status for digital inputs A.1 – A.6 A1 = LSB
V1.30.3	PositCtrl Status		1514	Status of position controller

Table 2. Monitor values.

5.2 Basic parameters (Control keypad: Menu M2 → G2.1)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.1.1	Max Frequency	0	320,00		50,00		102	**NOTE**: If P2.1.2 > P2.1.7, check if the motor is suitable
P2.1.2	Acceleration time 1	0,01	300,00	s	3,00		103	Acceleration time for speed control (not used with position control enabled.)
P2.1.3	Deceleration time 1	0,01	300,0	s	3,00		104	Deceleration time for speed control (not used with position control enabled.)
P2.1.4	Current limit	0,3 x I_H	2 x I_H	A	I_L		107	**NOTE**: The formulas apply for inverter up to FR7 sizes. For higher sizes, contact the manufacturer.
P2.1.5	Nominal Voltage of the motor	180	690	V	400V		110	Check the rating plate of the motor.
P2.1.6	Nominal frequency of the motor	30,00	320,00		50,00		111	Check the rating plate of the motor.
P2.1.7	Nominal speed of the motor	300	20 000	Rpm	Varies		112	Nominal speed of the motor
P2.1.8	Nominal current of the motor	0,3 x I_H	2 x I_H	A	I_H		113	Check the rating plate of the motor. **NOTE:** even if the default is fair, confirm the value with edit/enter button to automatic set of magnetizing current.
P2.1.9	Motor CosPhi	0,30	1,00		0,85		120	Power factor. Check the rating plate of the motor
P2.1.10	I/O reference	0	14		0		117	Speed reference with I/O terminal control place **0**=AI1 **1**=AI2 **2**=System Bus PD1 **3**=Not used **4**=Not used **5**=Not used **6**=AI1 Joystick **7**=AI2 Joystick **8**=Keypad **9**=fieldbus **10**=Motor potentiometer **11**=Min (AI1, AI2) **12**=Max (AI1, AI2) **13**=Max Frequency **14**=Sel AI1/AI2
P2.1.11	Keypad control reference	0	9		8		121	Speed reference with Keypad control place **0**=AI1 **1**=AI2 **2**=System Bus PD1 **3**=Not used **4**=Not used **5**=Not used **6**=AI1 Joystick **7**=AI2 Joystick **8**=Keypad **9**=fieldbus

P2.1.12	Fieldbus control reference	0	9		9		122	Speed reference with fieldbus control place ,see P2.1.13
P2.1.13	Preset speed 1	0,00	P2.1.		10,00		105	Preset speed 1
P2.1.14	Preset speed 2	0,00	P2.1.		15,00		106	Preset speed 2

Table 3. Basic parameters G2.1

5.3 Input signals

5.3.1 Basic settings (Control keypad: menu M2 → G2.2.1)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.2.1.1	Start/Stop Logic selection	0	7		0		300	Start signal **1** (Default: A.1) / Start signal **2** **0** Start fwd / Start rev **1** Start/Stop / Reverse **2** Start/Stop / Run Enable **3** Start pulse / Stop pulse **4** Start / Motopot. UP **5** Fwd Pulse / Rev. pulse **6** Start pulse / Rev. pulse **7** Start pulse / Enable pulse
P2.2.1.2	Motor potentiometer ramp time	0,1	2000,0	Hz/s	10,0		331	
P2.2.1.3	MotopMemRifFreq	0	2		1		367	Reset motopotentiometer ref.: **0**=No reset (stored) **1**=Reset if stopped or powered down **2**=Reset if powered down
P2.2.1.4	Adjust input	0	5		0		493	**A**djust input **0**=Not used **1**=AI1 **2**=AI2 **3**=<Not used> **4**=<Not used> **5**=Fieldbus PD8: 0 = P2.2.1.5 10000 = P2.2.1.6
P2.2.1.5	Adjust minimum	0,0	100,0	%	0,0		494	Percentage of min. input adjust
P2.2.1.6	Adjust maximum	0,0	100,0	%	0,0		495	Percentage of max. input adjust

Table 4. Input signals: Basic settings, G2.2.1

5.3.2 Analogue input 1 (Control keypad: Menu M2 → G2.2.2)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.2.2.1	AI1 signal selection	0.1	E.10		A.1		377	Analogue input 1 selection
P2.2.2.2	AI1 filter time	0,00	10,00	s	0,10		324	AI1 signal filter time constant, 0=no filtering
P2.2.2.3	AI1 signal range	0	3		0		320	0= 0—100% 1= 4mA/20%—100% 2= Custom range.
P2.2.2.4	AI1 custom minimum setting	0,00	100,00	%	0,00		321	Custom minimum setting
P2.2.2.5	AI1 custom maximum setting	0,00	100,00	%	100,00		322	Custom maximum setting
P2.2.2.6	AI1 reference scaling, minimum value	0,00	320,00		0,00		303	Select the frequency that corresponds to the min. reference signal
P2.2.2.7	AI1 reference scaling, maximum value	0,00	320,00		0,00		304	Select the frequency that corresponds to the max. reference signal

Table 5. Analogue input 1 parameters, G2.2.2

5.3.3 Analogue input 2 (Control keypad: Menu M2 → G2.2.3)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.2.3.1	AI2 signal selection	0.1	E.10		A.2		388	Analogue input 2 signal selection
P2.2.3.2	AI2 filter time	0,00	10,00	s	0,10		329	AI2 signal filter time constant, 0=no filtering
P2.2.3.3	AI2 signal range	0	3		1		325	0= 0—100% 1= 4mA/20%—100% 2= Custom range.
P2.2.3.4	AI2 custom minimum setting	0,00	100,00	%	0,00		326	Custom minimum setting
P2.2.3.5	AI2 custom maximum setting	0,00	100,00	%	100,00		327	Custom maximum setting
P2.2.3.6	AI2 reference scaling, minimum value	0,00	320,00		0,00		393	Select the frequency that corresponds to the min. reference signal
P2.2.3.7	AI2 reference scaling, maximum value	0,00	320,00		0,00		394	Select the frequency that corresponds to the max. reference signal.

Table 6. Analogue input 2 parameters, G2.2.3

5.3.4 Free analogue input signal (Control keypad: Menu M2 → G2.2.4)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	note
P2.2.4.1	Scaling of current limit	0	5		0		399	**0**=Not used **1**=AI1 **2**=AI2 **3**=Not used **4**=Not used **5**=Fieldbus (0-10000) full scale defined by P2.1.5
P2.2.4.2	Torque limit	0	5		0		485	**0**=Not used **1**=AI1 **2**=AI2 **3**=Not used **4**=Not used **5**=Fieldbus (0-10000) full scale defined by P2.5.14.11

Table 7. Free analogue input signal selection parameters, G2.2.4

5.3.5 Digital inputs (Control keypad: Menu M2 → G2.2.5)

Code	Parameter	Min	Default	Cust	ID	Note
Generic function input selectors						
P2.2.5.1	Start signal 1	DigIN:0.1	DigIN:A.1		403	See P2.2.1.1
P2.2.5.2	Start signal 2	DigIN:0.1	DigIN:0.1		404	See P2.2.1.1
P2.2.5.3	Run enable	DigIN:0.1	DigIN:0.2		407	Motor start enabled(cc)
P2.2.5.4	Reverse	DigIN:0.1	DigIN:0.1		412	Direction forward (oc) Direction reverse (cc)
P2.2.5.5	Preset speed 1	DigIN:0.1	DigIN:0.1		419	
P2.2.5.6	Preset speed 2	DigIN:0.1	DigIN:0.1		420	
P2.2.5.7	Motor potentiometer reference DOWN	DigIN:0.1	DigIN:0.1		417	Mot.pot. reference decreases (cc)
P2.2.5.8	Motor potentiometer reference UP	DigIN:0.1	DigIN:0.1		418	Mot.pot. reference increases (cc)
P2.2.5.9	Fault reset	DigIN:0.1	DigIN:0.1		414	All faults reset (cc)
P2.2.5.10	External fault close	DigIN:0.1	DigIN:0.1		405	Ext. fault displayed (cc)
P2.2.5.11	External fault open	DigIN:0.1	DigIN:0.2		406	Ext. fault displayed (oc)
P2.2.5.12	AI1/AI2 selection	DigIN:0.1	DigIN:0.1		422	Reference = AI1 (oc) Reference = AI2 (cc)
P2.2.5.13	Control from I/O terminal	DigIN:0.1	DigIN:0.1		409	Force control place to I/O terminal (cc)
P2.2.5.14	Control from keypad	DigIN:0.1	DigIN:0.1		410	Force control place to keypad (cc)
P2.2.5.15	Control from fieldbus	DigIN:0.1	DigIN:0.1		411	Force control place to fieldbus (cc)
P2.2.5.16	Parameter Set 1/2 selection	DigIN:0.1	DigIN:0.1		496	Parameter set selection Set 1 selected (oc) Set 2 selected (oc)
Input signals for Position Control selectors						
P2.2.5.17	Calibrate sensor	DigIN:0.1	DigIN:0.1		1520	Input for calibration sensor used
P2.2.5.18	Run calibration	DigIN:0.1	DigIN:0.1		1521	Calibration command
P2.2.5.19	Run Home Pos	DigIN:0.1	DigIN:A.6		1522	Home command (will start with calibration cycle automatically if calibration is not already done)
P2.2.5.20	Jog forward	DigIN:0.1	DigIN:A.2		1523	Jog forward
P2.2.5.21	Jog reverse	DigIN:0.1	DigIN:A.3		1524	Jog reverse
P2.2.5.22	Jog forward Inc	DigIN:0.1	DigIN:0.1		1525	Incremental jog forward
P2.2.5.23	Jog reverse Inc	DigIN:0.1	DigIN:0.1		1526	Incremental jog reverse
P2.2.5.24	PosCont Enable	DigIN:0.1	DigIN:0.1		1527	Position control enabled
P2.2.5.25	Automatic enable	DigIN:0.1	DigIN:0.1		1528	Automatic cycle selector **0**=Normal **1**=Automatic cycle See chapters 5.9.5 and 6.2.10
P2.2.5.26	Trigger	DigIN:0.1	DigIN:0.1		1529	Trigger for automatic cycle and "Go to position" Command (binary positions)
P2.2.5.27	Binary Pos B0	DigIN:0.1	DigIN:0.1		1530	Bit 0 selector for "Go to position" command
P2.2.5.28	Binary Pos B1	DigIN:0.1	DigIN:0.1		1531	Bit 1 selector for "Go to position" command
P2.2.5.29	Binary Pos B2	DigIN:0.1	DigIN:0.1		1532	Bit 2 selector for "Go to position" command
P2.2.5.30	Calibration type 2	DigIN:0.1	DigIN:0.1		1533	Select alternative calibration type 2 (selected by dig. input)
P2.2.5.31	Min end limit	DigIN:0.1	DigIN:0.1		1534	Min. Limit stop (possible to run FWD when active)
P2.2.5.32	Max End Limit	DigIN:0.1	DigIN:0.1		1535	Max. Limit stop (possible to run REV when active)

Table 8. Digital input signals, G2.2.5

cc = Contact closed
oc = Contact open

5.4 Output signals

5.4.1 Delayed digital output 1 (Keypad: Menu M2 → G2.3.1)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.1.1	Digital output 1 signal selection	0.1	E.10		0.1		486	Digital output signal selection
P2.3.1.2	Digital output 1 function	0	26		1		312	**0**=Not used **1**=Ready **2**=Run **3**=Fault **4**=Fault inverted **5**=FC overheat warning **6**=External fault or warning **7**=<Not used> **8**=Warning **9**=Reverse **10**=<Not used> **11**=At speed **12**=Undervoltage/ Over-voltage reg. active **13**=Freq. limit 1 superv. **14**=Freq. limit 2 superv. **15**=Torque limit superv. **16**=Ref. limit superv. **17**=External brake control **18**=Control place I/O terminal active **19**=FC temp. limit superv. **20**=Reference inverted **21**=External brake control inverted **22**=Therm. fault or warning **23**=<Not used> **24**=Fieldbus input data 1 **25**=Fieldbus input data 2 **26**=Fieldbus input data 3
P2.3.1.3	Digital output 1 on delay	0,00	320,00	s	0,00		487	0,00 = delay not used
P2.3.1.4	Digital output 1 off delay	0,00	320,00	s	0.00		488	0,00 = delay not used

Table 9. Delayed digital output 1 parameters, G2.3.1

5.4.2 Delayed digital output 2 (Keypad: Menu → G2.3.2)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.2.1	Digital output 2 signal selection	0.1	E.10		0.1		489	Digital output 2 signal selection
P2.3.2.2	Digital output 2 selection	0	26		0		490	See P2.3.1.2
P2.3.2.3	Digital output 2 on delay	0,00	320,00	s	0,00		491	0,00 = delay not used
P2.3.2.4	Digital output 2 off delay	0,00	320,00	s	0,00		492	0,00 = delay not used

Table 10. Digital output 2 parameters, G2.3.2

5.4.3 Digital output signals (Control keypad: Menu M2 → G2.3.3)

Code	Parameter	Min	Default	Cust	ID	Note
Generic function input selectors						
P2.3.3.1	Ready	0.1	A.1		432	
P2.3.3.2	Run	0.1	B.1		433	
P2.3.3.3	Fault	0.1	B.2		434	
P2.3.3.4	Fault inverted	0.1	0.1		435	Fault inverted
P2.3.3.5	Warning	0.1	0.1		436	
P2.3.3.6	External fault	0.1	0.1		437	External fault
P2.3.3.7	Overtemperature warning	0.1	0.1		439	Overtemperature warning
P2.3.3.8	Reverse	0.1	0.1		440	
P2.3.3.9	Unrequested direction	0.1	0.1		441	Unrequested direction
P2.3.3.10	At speed	0.1	0.1		442	
P2.3.3.11	External control place	0.1	0.1		444	External control place active
P2.3.3.12	External brake control	0.1	0.1		445	External brake control output active = Brake closed
P2.3.3.13	External brake control inverted	0.1	0.1		446	Ext. brake control inverted output active = Brake open
P2.3.3.14	Output frequency limit 1 supervision	0.1	0.1		447	Output frequency limit 1 supervision
P2.3.3.15	Output frequency limit 2 supervision	0.1	0.1		448	Output frequency limit 2 supervision
P2.3.3.16	Reference limit supervision	0.1	0.1		449	Reference limit supervision
P2.3.3.17	Temperature limit supervision	0.1	0.1		450	Temperature limit supervision
P2.3.3.18	Torque limit supervision	0.1	0.1		451	Torque limit supervision
P2.3.3.19	Motor thermal protection	0.1	0.1		452	Warning or fault motor thermal protection
P2.3.3.20	Motor regulator active	0.1	0.1		454	Undervoltage / Overvoltage regulator active
P2.3.3.21	Fieldbus input data 1	0.1	0.1		455	Digital input 1 from fieldbus
P2.3.3.22	Fieldbus input data 2	0.1	0.1		456	Digital input 2 from fieldbus
P2.3.3.23	Fieldbus input data 3	0.1	0.1		457	Digital input 3 from fieldbus
Output signals for position control selectors						
P2.3.3.24	Axis ready	0.1	0.1		1540	Output active = Positioning operation is performed
P2.3.3.25	Calibration OK	0.1	0.1		1541	Output active = Calibration cycle is done
P2.3.3.26	In Home Pos.	0.1	0.1		1542	Output active = Home mission completed
P2.3.3.27	In Position	0.1	0.1		1543	Output active = Position mission completed
P2.3.3.28	HomePos OR InPos	0.1	0.1		1544	Output active = Position mission OR Home mission completed
P2.3.3.29	Fault and stopped	0.1	0.1		1545	Output active = Drive faulted and ramp stopped. Useful for synchronization of emergency brake
P2.3.3.30	Fault and stopped, inverted logic	0.1	0.1		1546	Output not active = Drive faulted and ramp stopped. Useful for synchronization of emergency brake

Table 11. Output digital signals, G2.3.3

WARNING	**Be ABSOLUTELY sure not to connect two functions to one and same output in order to avoid function** overruns and to ensure flawless operation.

5.4.4 Limit settings (Control keypad: Menu M2 → G2.3.4)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.4.1	Output frequency limit 1 supervision	0	3		0		315	**0**=Not used **1**=Low limit supervision **2**=High limit supervision **3**=External brake control
P2.3.4.2	Output frequency limit 1: Supervised value	0,00	P2.1.2		0,00		316	Threshold supervision output frequency 1
P2.3.4.3	Output frequency limit 2 supervision	0	4		0		346	**0**=Not used **1**=Low limit supervision **2**=High limit supervision **3**=External brake control **4**=External opening/ closure brake control
P2.3.4.4	Threshold supervision output frequency 2	0,00	P2.1.2		0,00		347	Threshold supervision output frequency 2
P2.3.4.5	Torque limit supervision	0	3		0		348	**0**=Not used **1**=Low limit supervision **2**=High limit supervision **3**=External brake control
P2.3.4.6	Threshold torque supervision	0,0	300,0	%	100,0		349	Threshold torque supervision
P2.3.4.7	Reference limit supervision	0	2		0		350	**0**=Not used **1**=Lower limit **2**=Upper limit
P2.3.4.8	Reference limit supervision value	0,0	100,0	%	0,00		351	Reference limit supervision value(% of P2.1.)
P2.3.4.9	External brake on delay	0,0	100,0	s	0,5		352	External brake on delay
P2.3.4.10	External brake off delay	0,0	100,0	s	1,5		353	External brake off delay
P2.3.4.11	FC temperature supervision	0	2		0		354	**0**=Not used **1**=Lower limit **2**=Upper limit
P2.3.4.12	FC temperature supervision value	–10	75	°C	0		355	FC temperature supervision value

Table 12. Limit settings, G2.3.4

5.4.5 Analogue output 1 (Control keypad: Menu M2 → G2.3.5)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.5.1	Analogue output 1 signal selection	0.1	E.10		A.1		464	Analogue output 1 signal selection
P2.3.5.2	Analogue output 1 function	0	13		1		307	Analogue output 1 function: **0**=Not used **1**=Output freq. (0—f_{max}) **2**=Freq. reference (0—f_{max}) **3**=Motor speed (0-Vel.nomin.) **4**=Output current (0-I_{nMot}) **5**=Motor torque (0-T_{nMot}) **6**=Motor power (0-P_{nMot}) **7**=Motor voltage (0-U_{nMot}) **8**=DC link voltage (0—1000V) **9**=AI1 **10**=AI2 **11**=Output freq. (f_{min} - f_{max}) **12**=Motor torque (-2x...+2xT_{Nmot}) **13**=Motor power (-2x...+2xT_{Nmot}) **14**=Frequency ref. from position control (0-f_{max}) **15**=Encoder frequency (0-f_{max})
P2.3.5.3	Analogue output 1 filter time	0,00	10,00	s	1,00		308	Analogue output 1 filter time constant
P2.3.5.4	Analogue output 1 inversion	0	1		0		309	**0**=Not inverted **1**=Inverted
P2.3.5.5	Analogue output 1 minimum	0	1		0		310	**0**=0 mA **1**=4 mA
P2.3.5.6	Analogue output 1 scale	10	1000	%	100		311	Analogue output 1 scale factor

Table 13. Analogue output 1 parameters, G2.3.5

5.5 Drive control (Control keypad: Menu M2 → G2.4)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.4.1	Brake chopper	0	3		0		504	**Brake chopper** **0**=Disabled **1**=Enabled in RUN state **2**=External brake chopper **3**=Enabled in RUN and STOP state **4**=Enabled in RUN state, no supervision test
P2.4.2	Start function	0	1		0		505	**0**=Ramping **1**=Flying start
P2.4.3	Stop function	0	1		1		506	**0**=Coasting **1**=Ramping
P2.4.4	DC braking current	0,3 x I_H	2 x I_H	A	I_H		507	Current for DC braking **NOTE**: The formulas are approximate
P2.4.5	DC brake time at stop	0,000	60,000	s	0,000		508	DC brake time at stop **0**=DC brake is off at stop
P2.4.6	Frequency to start DC braking during ramp stop	0,10	10,00		1,50		515	Frequency to start DC braking during ramp stop
P2.4.7	DC brake time at start	0,000	60,000	s	0,000		516	DC brake time at start **0**=DC brake is off at start
P2.4.8	Flux brake	0	1		0		520	Flux brake **0**=Not active **1**=Active
P2.4.9	Flux braking current	0,3 x I_H	2 x I_H	A	I_H		519	Flux braking current **NOTE**: The formulas are approximate

Table 14. Drive control parameters, G2.4

5.6 Motor control parameters (Control keypad: Menu M2 → G2.5)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.5.1	Motor control mode	0	6		0		600	**0**=Frequency control **1**=Speed control **2**=<Not used> **3**=CL speed control **4**=<Not used> **5**=Advanced OL frequency control **6**=Advanced OL speed control
P2.5.2	U/f optimisation	0	1		0		109	**0**=Not used **1**=Automatic torque boost
P2.5.3	U/f ratio selection	0	3		0		108	**0**=Linear **1**=Squared **2**=Programmable **3**=Linear with flux optim.
P2.5.4	Field weakening point	8,00	320,00	Hz	50,00		602	
P2.5.5	Voltage at field weakening point	10,00	200,00	%	100,00		603	n% x U_{nmot}
P2.5.6	U/f curve midpoint frequency	0,00	par. P2.6.4	Hz	50,00		604	
P2.5.7	U/f curve midpoint voltage	0,00	100,00	%	100,00		605	n% x U_{nmot} Parameter max. value = par. 2.6.5
P2.5.8	Output voltage at zero frequency	0,00	40,00	%	Varies		606	n% x U_{nmot}
P2.5.9	Switching frequency	1,0	Varies	kHz	Varies		601	
P2.5.10	Overvoltage controller	0	1		1		607	Overvoltage controller **0**=Not enabled **1**=Enabled
P2.5.11	Undervoltage controller	0	1		1		608	Undervoltage controller **0**=Not enabled **1**=Enabled
P2.5.12	Rs voltage drop	0	30000		Varies		662	
P2.5.13	Identification	0	5		0		631	**0**=No Action **1**=ID No Run **2**=ID With Run **3**=Enc. ID Run **4**=No Action **5**=ID run failed
G2.5.14 CLOSED LOOP								
G2.5.15 PMSM CALIBRATION								

Table 15. Motor control parameters and submenus, G2.5, G2.5.14, G2.5.15

5.6.1 Closed loop (Control keypad: Menu M2 → G2.5.13)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.5.14.1	Magnetizing current	0	Varies	A	40% I_{nmot}		612	Magnetizing current
P2.5.14.2	Speed control Kp	0	1000		30		613	Speed control prop. gain
P2.5.14.3	Speed control Ti	0,0	500,0	ms	10,0		614	Speed control I time constant (0=integr. action not active)
P2.5.14.4	Start 0-speed time	0	32000	ms	0		615	0-speed time at start
P2.5.14.5	Stop 0-speed time	0	32000	ms	0		616	0-speed time at stop
P2.5.14.6	Current control Kp	0,00	300,00	%	40,00		617	Current control prop. gain
P2.5.14.7	Encoder 1 filter time	0	1000	ms	0		618	Encoder filter time
P2.5.14.8	Slip adjust	0	500	%	100		619	Slip adjust
P2.5.14.9	Load drooping	0,00	100,00	%	0,00		620	Drooping at nominal load ("droop") n% x Motor Nom.Speed
P2.5.14.10	Start up torque	0	1		0		621	**0**=Not used **1**=Used
P2.5.14.11	Torque Limit	0,0	400,0	%	400,0		609	Torque limit, full scale for free analogue input
P2.5.14.12	Threshold speed Kp F1	P2.6.7.14	320,00		2,00		1823	Higher limit for speed proportional gain variation
P2.5.14.13	Threshold speed Kp F0	0,00	P2.6.7.13		1,00		1822	Lower limit for speed proportional gain variation
P2.5.14.14	% of speed control P gain at F0	0	100	%	50		1824	Variation of speed P gain at zero frequency

Table 16. Motor control parameters, closed loop G2.5.14

5.6.2 PMSM settings (Control keypad: Menu M2 → G2.5.15)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.5.15.1	Motor type	0	1	-	0		650	**0**=Asynchronous motor **1**=PMSM motor ("AC brushless")
P2.5.15.2	FluxCurrent Kp	0	32000		500		651	Gain for flux current control
P2.5.15.3	FluxCurrent Ti	0	1000	ms	50		652	Integral time for flux control
P2.5.15.4	PMSM ShaftPosition	0	65535		0		649	Low word of encoder angle corresponding to the shaft 0 position
P2.5.15.5	EnableRsIdentific	0	1		0		654	Enable Rs identification during DC brake at start
P2.5.15.6	ModIndexLimit	0	200		100		655	Modulaton index limit at field weakening point

Table 17. Parameters for permanent magnet synchronous motor, G2.5.15

5.7 Protections (Control Keypad: Menu M2 → G2.6)

Codice	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.6.1	External fault	0	3		2		701	0=No response 1=Warning 2=Fault, stop acc. to P2.4.3 3=fault, stop by coasting
P2.6.2	Input phases supervision	0	3		0		730	As P2.6.1
P2.6.3	Response to undervoltage fault	1	3		2		727	As P2.6.1
P2.6.4	Output phases supervision	0	3		2		702	As P2.6.1
P2.6.5	Earth fault protection	0	3		2		703	As P2.6.1
P2.6.6	Thermal protection of the motor	0	3		2		704	As P2.6.1
P2.6.7	Motor ambient temperature factor	–100,0	100,0	%	0,0		705	
P2.6.8	MTP:Cooling factor at 0 speed	0,0	150,0	%	40,0		706	MTP:Cooling factor at 0 speed: N% x I_{nmot}
P2.6.9	MTP:Motor thermal time constant	1	200	min	45		707	
P2.6.10	Motor duty cycle	0	100	%	100		708	
P2.6.11	Response to thermistor fault	0	3		0		732	As P2. 6.1
P2.6.12	Response to fieldbus fault	0	3		2		733	As P2. 6.1
P2.6.13	Response to slot fault	0	3		2		734	As P2. 6.1
P2.6.14	Position range error	0	2		0		1560	Exceeding positioning range error (±32000 u from zero point); As P2. 6.1
P2.6.15	Dynamic error	0	2		0		1561	Position error exceeding dynamic limit (P2.8.7.7) As P2. 6.1
P2.6.16	Static error	0	2		0		1562	Position error exceeding static limit (P2.8.7.5) As P2. 6.1

Table 18. Protections, G2.6

5.8 Autorestart parameters (Control keypad: Menu M2 → G2.7)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.7.1	Wait time	0,10	10,00	s	0,50		717	Wait time before auto-matic restart
P2.7.2	Trial time	0,00	60,00	s	30,00		718	The max. time in which it is possible to restart the drive
P2.7.3	Start function	0	2		0		719	0=Ramping 1=Flying start 2=Fault, stop acc. to P2.4.3
P2.7.4	Number of tries after undervoltage trip	0	10		0		720	Max number of tries after undervoltage trip
P2.7.5	Number of tries after overvoltage trip	0	10		0		721	Max number of tries after overvoltage trip
P2.7.6	Number of tries after overcurrent trip	0	3		0		722	Max number of tries after overcurrent trip
P2.7.8	Number of tries after motor temperature fault trip	0	10		0		726	Max number of tries after motor temperature fault trip
P2.7.9	Number of tries after external fault	0	10		0		725	Number of tries after external fault

Table 19. Automatic restart parameters, G2.7

5.9 Position control parameters (Control keypad: Menu M2 → G2.8)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.8.1	PosControllerEn	0	3		0		1570	0=Disabled or enabled by digital input 1=Enabled 2=Enable by fieldbus
P2.8.2	EncoderSelection	0	1		0		1571	(only with OPT-A7, OPT-BC option board) 0=Enc1 (motor) 1=Enc2 (auxiliary)
P2.8.3	Distance	1	32767	U	100		1572	Distance in user unit [u] corresponding to the number of turns specified by P2.8.4
P2.8.4	Turns	1	163	Turns	1		1573	Encoder turns corresponding to the distance specified by P2.8.3
P2.8.5	Maximum speed	1	18101	u/s	1200		1574	Maximum axis speed in user unit/sec
P2.8.6	Max. acceleration	1	25500	u/ss	1200		1575	Maximum acceleration in user unit/sec^2. Acceleration time is yelded by P2.8.5 / P2.8.6
G2.8.7 ADVANCED FUNCTIONS								
G2.8.8 ZERO HOME								
G2.8.9 JOG								
G2.8.10 POSITIONS								
G2.8.11 AUTOMATIC CYCLE								

Table 20. Position control parameters and submenu, G2.8, G2.8.7, G2.8.8, G2.8.9, G2.8.10, G2.8.11

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5.9.1 Advanced functions (Control keypad: Menu M2 → G2.8.7)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.8.7.1	Max position	P2.8.7.2	60000	U	60000		1580	Axis maximum position
P2.8.7.2	Min position	5000	P2.8.7.1	U	5000		1581	Axis minimum position
P2.8.7.3	Proportional gain	1	100	1/s	15		1582	Position control proportional gain
P2.8.7.4	TargetDelta	0	P2.8.7.5	U	0		1583	Position tolerance at end of mission
P2.8.7.5	Static error	1	32767	U	10		1584	Limit for static distance error fault (F62)
P2.8.7.6	Settling time	0,02	5,00	s	0,10		1585	Settling time for transition from dynamic error supervision to static error supervision at end of mission
P2.8.7.7	Dynamic error	P2.8.7.5	32767	U	1000		1586	Limit for dynamic distance error fault (F61)
P2.8.7.8	Calibration on Home	0	1		0		1587	Calibration operation before home mission **0**=Only the first time **1**=At every home command
P2.8.7.9	Trig Mode	0	1		1		1588	Position commands **0**=Pulse (edge) **1**=Permanent (level)
P2.8.7.10	Speed Reference	0	2		0		1589	Positioning speed **0**=By parameters **1**=By analogue input AI1 **2**=By analogue input AI2 the full/scale range is up to P2.8.5
P2.8.7.11	Distance ExtEnc	1	32767	u/s	100		1576	Distance in user unit [u] corresponding to the number of turns specified by P2.8.7.12
P2.8.7.12	Turns ExtEncoder	1	163	turn	1		1577	External Encoder (CH2) turns corresponding to the distance specified by P2.8.7.11

Table 21. Position control parameters, Advanced functions G2.8.7

5.9.2 Calibration/home parameters (Control keypad: Menu M2 → G2.8.8)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.8.8.1	Calibration type 1	0	7		0		1595	Zero setting mode 0=Actual position (manual) 1=Reference position (incr) 2=Z-pulse, posit. direction 3=Z-pulse, neg. direction 4=Sensor, FWD fast, REV slow 5=Sensor, REV fast, FWD slow 6=Cam, positive direction 7=Cam, negative direction
P2.8.8.2	Calibration speed	1	P2.8.5	u/s	100		1596	Calibration setting speed
P2.8.8.3	Calibration high speed	1	P2.8.5	u/s	500		1597	Calibration approach fast speed during first phase in calibration modes 4,5
P2.8.8.4	Calib. preset	P2.8.7.2	P2.8.7.1	u	10000		1598	Calibration position offset
P2.8.8.5	Home speed	1	P2.8.5	u/s	1200		1599	Home positioning speed
P2.8.8.6	Home acceleration	1	P2.8.6	u/ss	1200		1600	Homing acceleration/ deceleration During Home positioning, the acceleration time is P2.8.8.4/ P2.8.8.5
P2.8.8.7	Home position	P2.8.7.2	P2.8.7.1	u	10000		1601	
P2.8.8.8	Calibration type 2	0	7		0		1602	Alternate calibration operation mode, selected by digital input. Values same as P2.8.8.1
P2.8.8.9	Max calib. travel	0		u	0		1603	Max moving distance during calibration cycle. Ignored if 0.

Table 22. Position control parameters, calibration setting and Home G2.8.8

5.9.3 Jog parameters (Control keypad: Menu M2 → G2.8.9)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.8.9.1	Jogging speed	1	P2.8.5	u/s	120		1610	
P2.8.9.2	Jog acceleration	1	P2.8.6	u/ss	1200		1611	Jog acceleration and deceleration. The acceleration time is P2.8.9.1/ P2.8.9.2
P2.8.9.3	Jog Inc Distance	1	65535	U	100		1612	Position increment for jog

Table 23. Position control parameters, jog G2.8.9

5.9.4 Positions parameters (Control keypad: Menu M2 → G2.8.10)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.8.10.1	000 position	P2.8.7.2	P2.8.7.1	u	12000		1620	Position selected by B2=0, B1=0, B0=0
P2.8.10.2	000 speed	1	P2.8.5	u/s	1200		1621	Positioning speed
P2.8.10.3	000 accel	1	P2.8.6	u/ss	1200		1622	Positioning acceleration. The acceleration time is P2.8.10.1 / P2.8.10.2
P2.8.10.4	001 position	P2.8.7.2	P2.8.7.1	u	14000		1623	Position selected by B2=0, B1=0, B0=1
P2.8.10.5	001 speed	1	P2.8.5	u/s	0		1624	If parameter is set to 0 the P2.8.10.2 speed is used.
P2.8.10.6	001 accel	1	P2.8.6	u/ss	0		1625	If parameter is set to 0 the P2.8.10.3 acceleration is used.
P2.8.10.7	010 position	P2.8.7.2	P2.8.7.1	u	16000		1626	Position selected by B2=0, B1=1, B0=0
P2.8.10.8	010 speed	1	P2.8.5	u/s	0		1627	If parameter is set to 0 the P2.8.10.2 speed is used.
P2.8.10.9	010 accel	1	P2.8.6	u/ss	0		1628	If parameter is set to 0 the P2.8.10.3 acceleration is used.
P2.8.10.10	011 position	P2.8.7.2	P2.8.7.1	u	18000		1629	Position selected by B2=0, B1=1, B0=1
P2.8.10.11	011 speed	1	P2.8.5	u/s	0		1630	If parameter is set to 0 the P2.8.10.2 speed is used.
P2.8.10.12	011 accel	1	P2.8.6	u/ss	0		1631	If parameter is set to 0 the P2.8.10.3 acceleration is used.
P2.8.10.13	100 position	P2.8.7.2	P2.8.7.1	u	20000		1632	Position selected by B2=1, B1=0, B0=0
P2.8.10.14	100 speed	1	P2.8.5	u/s	0		1633	If parameter is set to 0 the P2.8.10.2 speed is used.
P2.8.10.15	100 accel	1	P2.8.6	u/ss	0		1634	If parameter is set to 0 the P2.8.10.3 acceleration is used.
P2.8.10.16	101 position	P2.8.7.2	P2.8.7.1	u	22000		1635	Position selected by B2=1, B1=0, B0=1
P2.8.10.17	101 speed	1	P2.8.5	u/s	0		1636	If parameter is set to 0 the P2.8.10.2 speed is used.
P2.8.10.18	101 accel	1	P2.8.6	u/ss	0		1637	If parameter is set to 0 the P2.8.10.3 acceleration is used.
P2.8.10.19	110 position	P2.8.7.2	P2.8.7.1	u	24000		1638	Position selected by B2=1, B1=1, B0=0
P2.8.10.20	110 speed	1	P2.8.5	u/s	0		1639	If parameter is set to 0 the P2.8.10.2 speed is used.
P2.8.10.21	110 accel	1	P2.8.6	u/ss	0		1640	If parameter is set to 0 the P2.8.10.3 acceleration is used.
P2.8.10.22	111 position	P2.8.7.2	P2.8.7.1	u	26000		1641	Position selected by B2=1, B1=1, B0=1
P2.8.10.23	111 speed	1	P2.8.5	u/s	0		1642	If parameter is set to 0 the P2.8.10.2 speed is used.
P2.8.10.24	111 accel	1	P2.8.6	u/ss	0		1643	If parameter is set to 0 the P2.8.10.3 acceleration is used.

Table 24. Position control parameters, Positions G2.8.10

5.9.5 Automatic cycle parameters (Control Keypad: Menu M2 → G2.8.11)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.8.11.1	PositControlMode	0	1		0		1650	Operating mode: **0**=Normal **1**=Automatic cycle
P2.8.11.2	EnManual Commands	0	1		0		1651	Enable normal commands in automatic cycle: **0**=No **1**=Yes
P2.8.11.3	First command	0	11		0		1652	First command of automatic cycle **0**=None(end cycle) **1**=Go to 000 position **2**=Go to 001 position **3**=Go to 010 position **4**=Go to 011 position **5**=Go to 100 position **6**=Go to 101 position **7**=Go to 110 position **8**=Go to 111 position **9**=Incremental jog fwd **10**=Increm. Jog reverse **11**=Home
P2.8.11.4	Pause 1	0,0	10,0	s	0,0		1653	Dwell after 1st command
P2.8.11.5	TrigMode 1-2	0	1		0		1654	Trigger mode for 2nd command execution **0**=Normal (wait for trigger) **1**=Auto (start after dwell)
P2.8.11.6	Second command	0	11		0		1655	2nd cmd of automatic cycle, see P2.8.11.3
P2.8.11.7	Pause 2	0,0	10,0	s	0,0		1656	Dwell after 2nd cmd
P2.8.11.8	TrigMode 2-3	0	1		0		1657	Trigger mode for 3rd command execution **0**=Normal (wait for trigger) **1**=Auto (start after dwell)
P2.8.11.9	Third command	0	11		0		1658	3rd cmd of automatic cycle, see P2.8.11.3
P2.8.11.10	Pause 3	0,0	10,0	S	0,0		1659	Dwell after 3rd command
P2.8.11.11	TrigMode 3-4	0	1		0		1660	Trigger mode for 4th command execution **0**=Normal (wait for trigger) **1**=Auto (start after dwell)
P2.8.11.12	Fourth command	0	11		0		1661	4th cmd of automatic cycle, see P2.8.11.3
P2.8.11.13	Pause 4	0,0	10,0	S	0,0		1662	Dwell after 4th command
P2.8.11.14	TrigMode 4-5	0	1		0		1663	Trigger mode for 5th command execution **0**=Normal (wait for trigger) **1**=Auto (start after dwell)
P2.8.11.15	Fifth command	0	11		0		1664	5th command of automatic cycle, see P2.8.11.3
P2.8.11.16	Pause 5	0,0	10,0	S	0,0		1665	Dwell after 5th command

P2.8.11.17	TrigMode 5-6	0	1		0		1666	Trigger mode for 6th command execution **0**=Normal (wait for trigger) **1=A**uto (start after dwell)
P2.8.11.18	Sixth command	0	11		0		1667	6th cmd of automatic cycle, see P2.8.11.3
P2.8.11.19	Pause 6	0,0	10,0	S	0,0		1668	Dwell after 6th command
P2.8.11.20	TrigMode 6-1	0	1		0		1669	Trigger mode for sequence repetition (1st cmd) **0=**Normal (wait for trigger) **1=**Auto (start after dwell)

Table 25. Position control parameters, Automatic cycle G2.8.11

5.10 Fieldbus parameters (Control keypad: Menu M2 → G2.9)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.9.1	Fieldbus data out 1 sel	1	10000		1514		852	Specify ID of variable to be associated with PD out 1 channel Default=status register pos. control
P2.9.2	Fieldbus data out 2 sel	1	10000		1503		853	Specify ID of variable to be associated with PD out 2 channel Default = position reference
P2.9.3	Fieldbus data out 3 sel	1	10000		1504		854	Specify ID of variable to be associated with PD out 3 channel Default = actual position
P2.9.4	Fieldbus data out 4 sel	1	10000		1505		855	Specify ID of variable to be associated with PD out 4 channel Default = position error
P2.9.5	Fieldbus data out 5 sel	1	10000		1124		856	Specify ID of variable to be associated with PD out 5 channel Default = encoder 1 speed
P2.9.6	Fieldbus data out 6 sel	1	10000		3		857	Specify ID of variable to be associated with PD out 6 channel Default = motor current
P2.9.7	Fieldbus data out 7 sel	1	10000		1510		858	Specify ID of variable to be associated with PD out 7 channel Default = torque in CL mode
P2.9.8	Fieldbus data out 8 sel	1	10000		37		859	Specify ID of variable to be associated with PD out 8 channel Default = last fault/warning code
P2.9.9	Cmd Register Sel	0	8		1/PDin1		1675	Select PD in channel for command register
P2.9.10	Speed Sel	0	8		2/Pdin2		1676	Select PD in channel for speed
P2.9.11	Acceleration Sel	0	8		3/Pdin3		1677	Select PD in channel for acceleration
P2.9.12	Position Sel	0	8		4/Pdin4		1678	Select PD in channel for position
P2.9.13	Deceleration Sel	0	8		0/None		1679	Select PD in channel for deceleration
P2.9.14	Torque Ref Sel	0	8		0/None		1680	Select PD in channel for torque reference
P2.9.15	Free Signal Sel	0	8		0/None		1681	Select PD in channel for free signal. Can be used for torque or current limit. See G2.2.4.

Table 26. Fieldbus parameters, G2.9

5.11 SystemBus parameters (Control keypad: Menu M2 → G2.10)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.10.1	System Bus Mode	0	3		0		1685	Node operating mode: **0**=Idle **1**=Normal **2**=Follower **3**=Master
G2.10.2 MASTER								
G2.10.3 FOLLOWER								

Table 27. System Bus parameters and submenus, G2.10. G2.10.2, G2.10.3

5.11.1 Master (Control keypad: Menu → G2.10.2)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.10.2.1	Master output	0	2		0		1686	Master output signal selection: **0**=Frequency (speed) **1**=Freq.(speed) Ref. after ramp **2**= Freq.(speed) Ref. before ramp

Table 28. System Bus parameters, Master G2.10.5

5.11.2 Follower (Control keypad: Menu → G2.10.3)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.10.3.1	ReferenceMultip	1	32767		1		1687	Reference multiplier
P2.10.3.2	ReferenceDivid	1	32767		1		1688	Reference divider

Table 29. System Bus parameters, Follower G2.10.3

5.12 Keypad control (Control keypad: Menu M3)

The parameters for the selection of control place and for control from the keypad are listed below. See the Keypad control menu in the product's User's Manual.

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P3.1	Control place	0	3		2		125	**0**=RS-232 serial link **1**=I/O terminal **2**=Keypad **3**=Fieldbus
R3.2	Keypad reference	0	P2.1.2					**Keypad reference (only in speed control mode)**
P3.3	Direction (on keypad)	0	1		0		123	**0**=Forward **1**=Reverse
P3.4	Stop button active	0	1		1		114	**0**=Limited function of stop button **1**=Stop button always enabled

Table 30. Keypad control parameters, M3

5.13 Jog teach

In this menu it is possible to jog the motor in forward and reverse direction to a position. The motor will run as long as the enter button is pressed (if no software limit or programmed input limit switch is reached) when parameter B3.5.2 or B3.5.3 is selected (Button function). The actual position can be copied to a parameter selected by P3.5.4.

NOTE: The calibration cycle has to be done to be able to perform Teach.
The position controller has to be enabled to be able to run Jog from this menu.

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P3.5.1	Jog Speed	1	P2.8.5	u/s	120		1610	Jogging speed
B3.5.2	Jog Forward	0	1		0			Button for Jog forward
B3.5.3	Jog Reverse	0	1		0			Button for Jog reverse
P3.5.4	Teach position	0	9		0		1696	**0**=Select (ready for teach) **1**=Home position **2**=000 position **3**=001 position **4**=010 position **5**=011 position **6**=100 position **7**=101 position **8**=110 position **9**=111 position

Table 31. Jos teach parameters

5.14 System menu (Control keypad: Menu M6)

For parameters and functions related to the general use of the frequency converter, such as application and language selection, customised parameter sets or information about the hardware and software, see Chapter 7.3.6 in the product's User's Manual.

5.15 Expander boards (Control board: Menu M7)

The M7 menu shows the expander and option boards attached to the control board and board-related information. For more information, see Chapter 7.3.7 in the product's User's Manual and the specific option reference manual.

6. FUNCTIONAL DESCRIPTION

6.1 Generical functions and speed regulation

For further information on general functions of software and speed control, see manual:

- "Vacon NX All in One Application Manual", code UD00885

6.2 Position control

The position control consists of the following functions:

- Control sequencer that manages commands, error conditions, axis state
- The initialization of absolute position (calibration, homing)
- The interpolating position regulator that generates the mission trajectory and the speed reference for the drive

6.2.1 PosControllerEn

The parameter P2.8.1 PosControllerEn enables the position control:

0 Disabled (speed control active)
1 Enabled (position control enabled, commands either from digital inputs or fieldbus)
2 Enabled from fieldbus (position control dynamically enabled and disabled from FB)

Alternatively to Parameter or fieldbus, it is possible to use a digital input selected by P2.2.5.24 PositCntrEn Sel parameter. Switching the enable while the inverter is running (either from digital input or fieldbus), the transition from speed control to position control takes place as follows:
1) the drive is stopped using the speed control mode ramp (P2.1.4)
2) activation of the position controller
The reverse transition (from position to speed control) is immediate.

6.2.2 The control sequencer: commands

The I/O terminals or fieldbus provide the commands. For safety, the default mode of positioning commands is "permanent" instead of "pulse" (P2.8.7.9 Trig Mode = 1/Permanent). This means the command must be kept active (high input level or high register's bit) up to the completion of the execution (that can be detected from the output terminals or from bits in the status register. If the input or the bit changes to low level during command execution, the axis is immediately stopped with the programmed deceleration for the current target. Alternatively, "pulse" logic can be used by setting P2.8.7.9 Trig Mode = 0/Pulse. This way the command execution is started by an impulse (which has to be longer than 20 ms). The execution will be completed even after the zero recovering of input level or command bit (see figures on page 37).

Note: Regardless of parameter P2.8.7.9, jog commands always use "permanent" logic; incremental jog and home commands always use "pulse" logic.

Note: Aside from parameter P2.8.7.9, no command is acknowledged as long as the mission execution referred to the previous command has not been completed. This also applies to the fieldbus interface.

Note: Incremental jog commands and Go to Position XXX commands are enabled only after the calibration cycle has been performed.

Commands use a few "arguments", they are usually specified through parameters or analogue input (see 6.2.3.3). When using fieldbus control and the automatic cycle is not active, process channels provide "arguments" of Go to Position command (see chapter 6.2.7). The other command "arguments" are always specified by parameters.

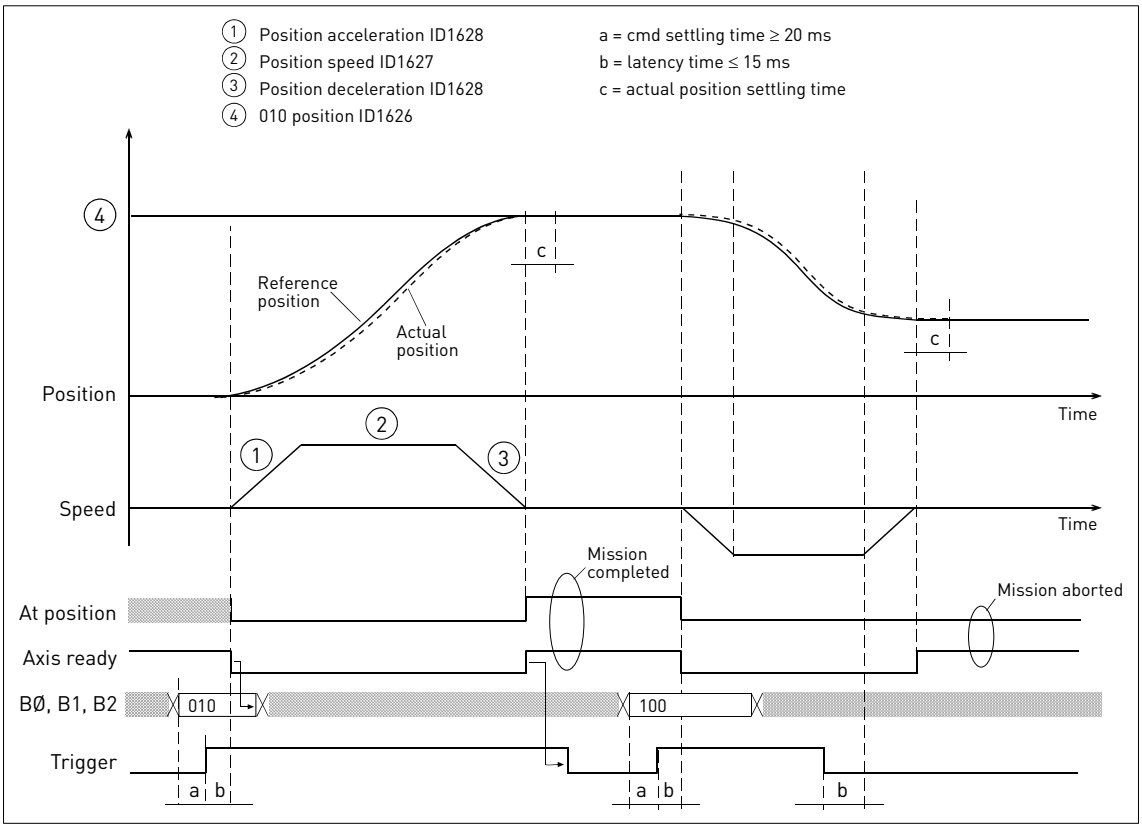

Figure 2. "Go to position" command with permanent logic

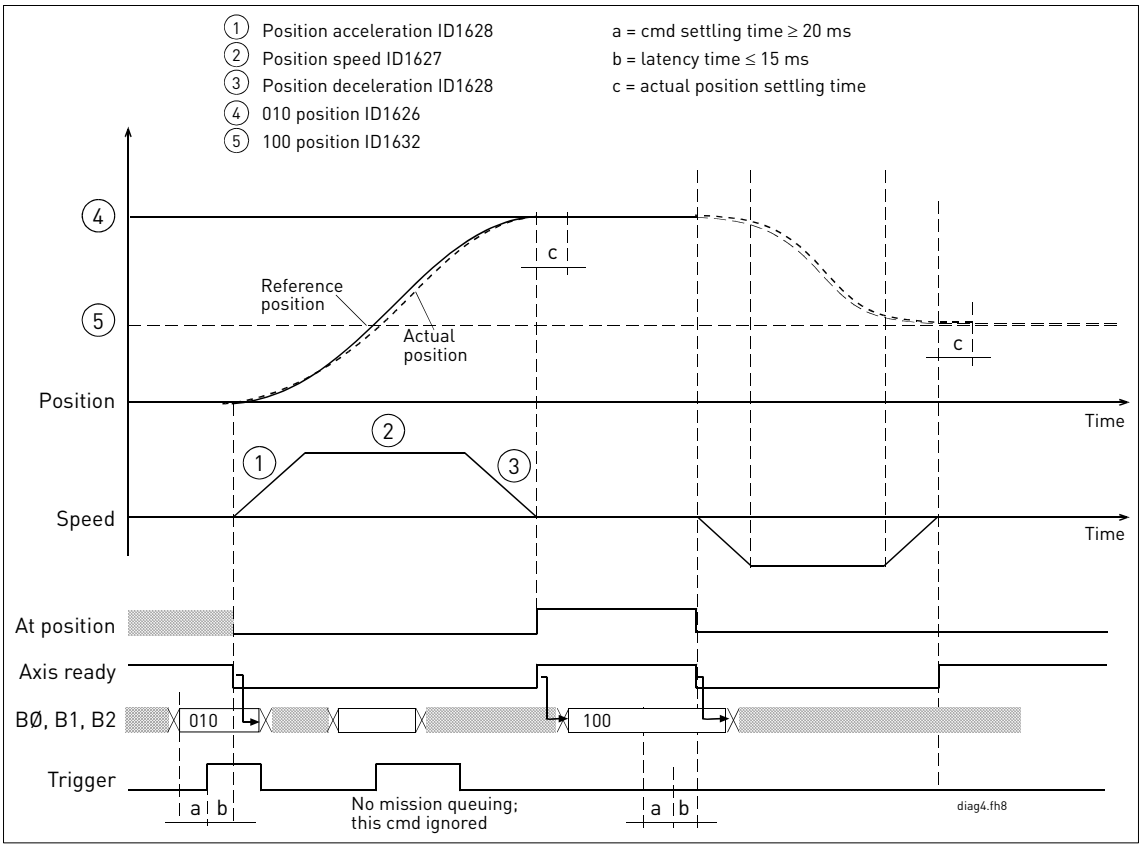

Figure 3. "Go to position" command with pulse logic

6.2.2.1 Calibration cycle

The calibration is needed to calibrate the axis to an absolute position at first start up and after a power down. This is always needed when an incremental encoder is used.
The calibration preset value P2.8.8.4 is initiated to the calibration position. The position actual count starts from this value when calibration is done. The calibration mode is selected by P2.8.8.1.
An alternative calibration Type 2 can be specified with parameter P2.8.8.8 Calibration type 2, and selected by digital input (to be configured with P2.2.5.30 Calibration Type 2). See chapter 6.2.8.

Calibration Parameters:

- *P2.8.8.2 Calibration speed*
- *P2.8.8.3 Calibration High Speed (only used in first phase of mode 4,5)*
- *P2.8.8.4 Calibration Preset (the value of calibration position)*

Acceleration and deceleration for the calibration cycle are set to 50% of the maximum, P2.8.6. The axis stops soon after the acknowledgement of calibration signal.

Note: The position reached at the end of the calibration cycle is not predetermined. After calibration, Home command can be used to move the axis up to a predetermined position.

After the successful execution of calibration cycle, Go to Position XXX and Incremental jog commands are enabled.
Execution of calibration cycle can be monitored by either keypad variable V1.19 in the Monitoring menu, or a digital output (configured with P2.3.3.25 Calibration OK) or status register bit 10.

6.2.2.2 "Home" (go to standby or initial position)

If the calibration cycle has not been performed, (V1.19 = 0, bit 10=0 in the status register), this command first performs the calibration cycle, and secondly a "Go to Home position" mission.
If calibration has already been performed, the "Home" command performs only the "Go to Home position" mission.

Note: Unconditioned execution of the calibration cycle can be forced whenever the Home command is performed with the following parameter:

P2.8.7.8 Calib. On Home = 1/ Yes

The parameters for the Home command are the sum of calibration parameters and positioning parameters.

- *P2.8.8.2 Calibration speed*
- *P2.8.8.3 Calibration high speed*
- *P2.8.8.4 Calibration Preset*
- *P2.8.8.5 Home speed*
- *P2.8.8.6 Home acceleration/deceleration*
- *P2.8.8.7 Home position*

The home acceleration time [s] is determined by parameters P2.8.8.5 / P2.8.8.6.

Note: Home and Position XXX position values can be interactively teached *(see Jog/Teach function)*
Note: Home and Position XXX missions can alternatively use speed from the analogue inputs (see chapter 6.2.3.3)

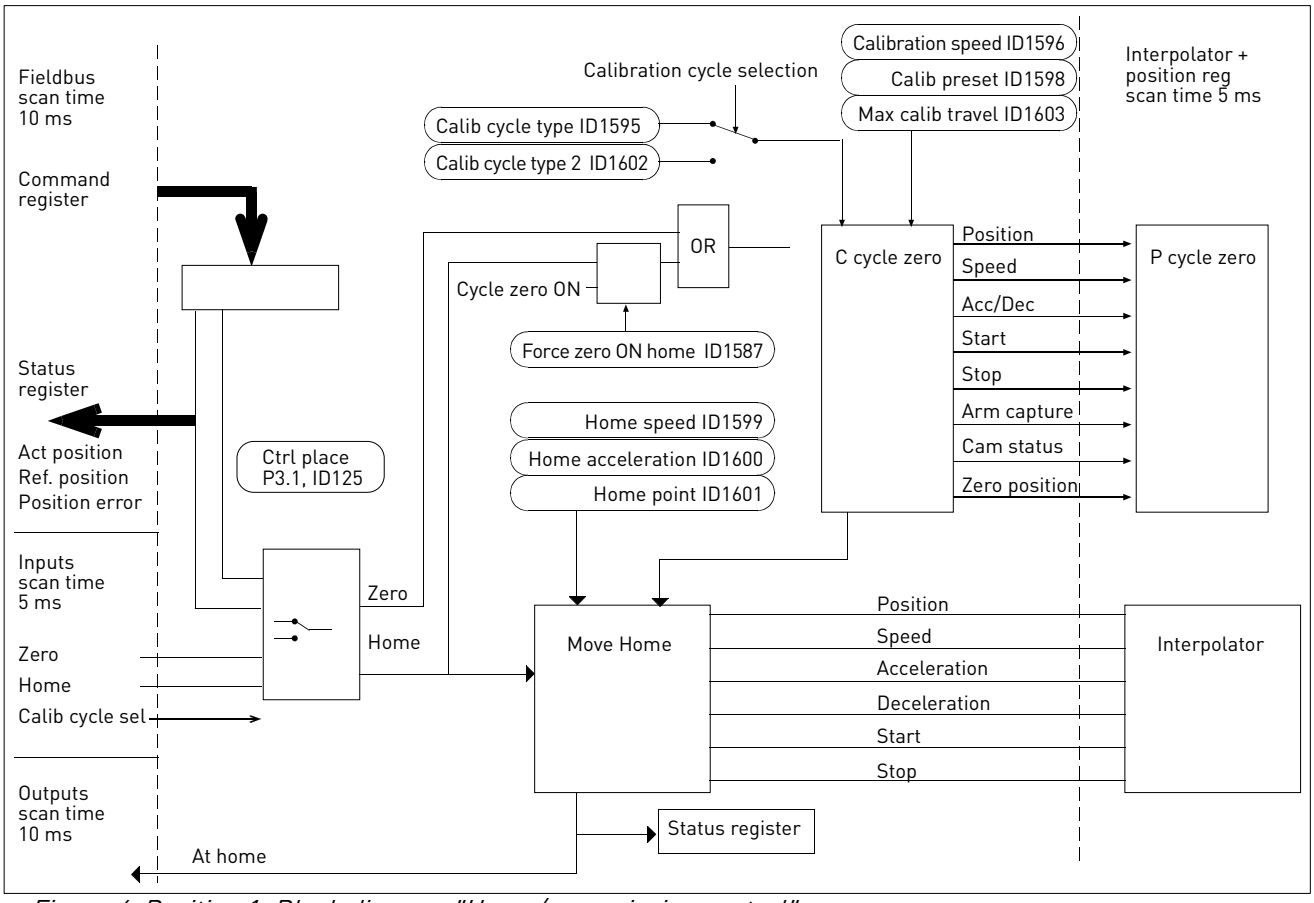

Figure 4. Position 1; Block diagram "Home/zero mission control"

6.2.2.3 Jog forward

Jog forward towards the positive direction of the position coordinate. Jog forward motion stops if the input or command bit are disabled (permanent logic). If calibration has been performed, Jog forward stops when the axis reaches its maximum position, P2.8.7.1.

Note: If calibration has not been performed, the operator is responsible for the holding of the axis in the safety area. Proper safety measures must be taken, providing end run cams to trip the emergency brake or to be connected to digital inputs and handled as stop limit contacts (P2.2.5.31, P2.2.5.32).

Parameters for the jog:

- *Jogging speed P2.8.9.1*
- *Jog acceleration/deceleration time P2.8.9.2*

Acceleration time [s] is determined by P2.8.9.1 / P2.8.9.2 parameters.

6.2.2.4 Jog reverse

Jog towards the negative direction of the position coordinate. Similar to jog forward (After the calibration cycle has taken place, the minimum position of the axis P2.8.7.2 limits the run).
Arguments: The same as jog forward command.

6.2.2.5 Incremental jog forward

Jog forward towards the positive direction of the position coordinate, with increase of determined distance. Input or command bit is carried out with pulse mode. The command is not enabled until the calibration cycle has taken place. If the final position of the incremental jog command exceeds the maximum position P2.8.7.1, the command is not executed. Parameters:

- *Jogging speed P2.8.9.1*
- *Jog acceleration/deceleration time P2.8.9.2*
- *Jog increment distance P2.8.9.3*

6.2.2.6 Incremental jog reverse

Similar to incremental jog forward, in the reverse direction. If the final position of the command exceeds the minimum position P2.8.7.2, the command is not executed.

6.2.2.7 Go to Position

Up to 8 positions with separate speed and acceleration can be selected by 3 digital inputs. This command is enabled only after the successful performance of the calibration cycle. The following parameters are used when controlling from terminal inputs:

- Position for selected binary command (000-111) according to Table 32.
- Speed for selected binary command (000-111)
- Acceleration for selected binary command (000-111)

One of 8 position parameters is selected by up to three encoded digital inputs configured with P2.2.5.27, P2.2.5.28, P2.2.5.29. A trigger digital input configured by P2.2.5.26 must be used to start the mission. The acceleration time in [s] is given by speed / acceleration.
If the speed or acceleration for a binary command is set to 0 the corresponding parameter for binary command 0 is used. See timing diagrams on pages 52 to 55.

B2 input	B1 input	B0 input	Position argument
Low	Low	Low	P2.8.10.1 Position 000
Low	Low	High	P2.8.10.4 Position 001
Low	High	Low	P2.8.10.7 Position 010
Low	High	High	P2.8.10.10 Position 011
High	Low	Low	P2.8.10.13 Position 100
High	Low	High	P2.8.10.16 Position 101
High	High	Low	P2.8.10.19 Position 110
High	High	High	P2.8.10.22 Position 111

Table 32. Position argument vs. Selection inputs

When controlling the drive from the fieldbus, position, speed, acceleration and deceleration data are given using the process data channels. See chapter 6.2.7.

Note: *The Home and Position parameters can be interactively teached using the Jog/teach function. See chapter 10.11.*

Note: *The speed and acceleration/deceleration for Home and Position commands can be alternatively modulated by an analogue input (see chapter 6.2.3.3)*

6.2.3 The control sequencer: inputs

A description of inputs for commands and service functions is herewith provided. Alternatively to I/O terminals, the fieldbus command/supervision interface is also available. (See chapter 6.2.7).

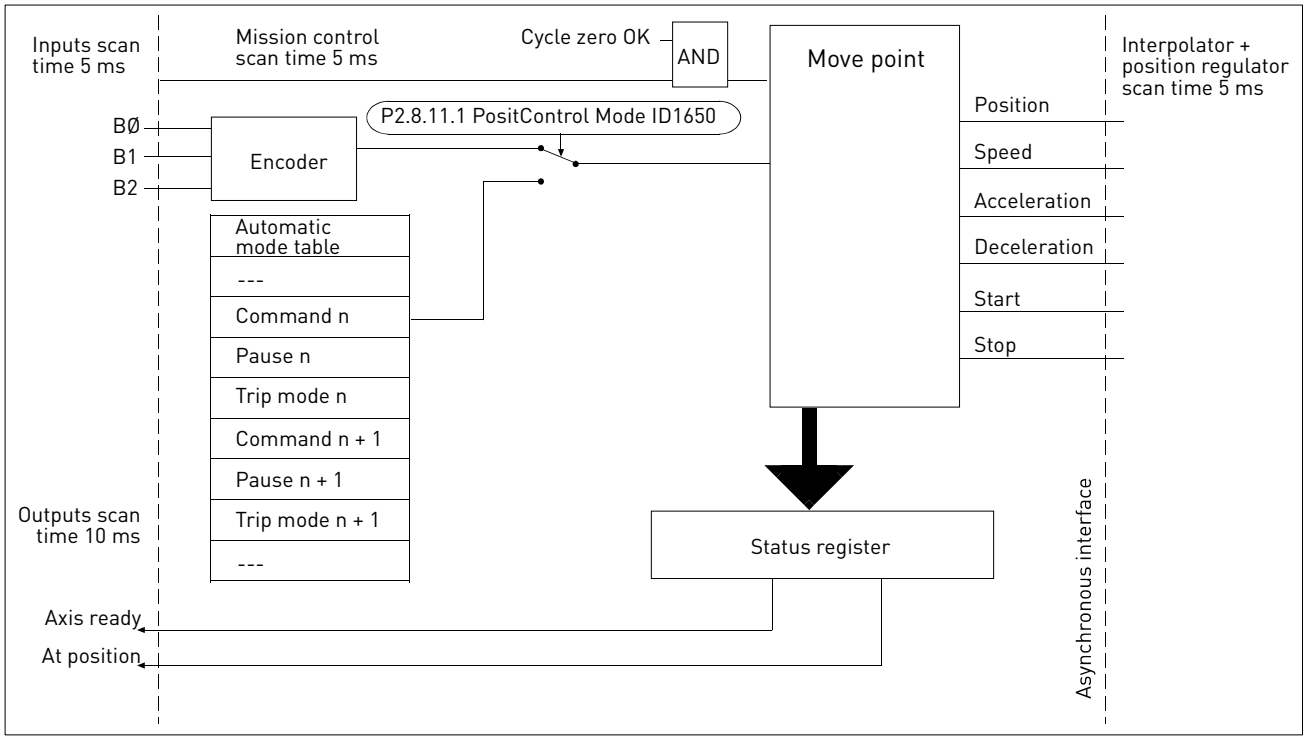

Figure 5. Position 1; Block diagram "Position mission control with I/O interface

6.2.3.1 Digital Inputs for commands

All digital inputs are individually programmable (for configuration mode see chapter 3). An input for drive RUN command must be used. Such input is programmable through P2.2.5.1 *Start signal 1* (default settings DigIN:A.1, terminal 8, OPT-A1 board)

Command inputs can be configured with the following parameters:

P2.2.5.18 Calibration command input selection
P2.2.5.19 Home command input selection (default DigIN:A.6, terminal 16, board A1)
P2.2.5.20 Jog forward command input selection (default DigIN:A.2, terminal 9, board A1)
P2.2.5.21 Jog reverse command input selection (default DigIN:A.3, terminal 10, board A1)
P2.2.5.22 Incremental jog forward command input selection
P2.2.5.23 Incremental jog reverse command input selection
P2.2.5.26 Trigger for position command and for automatic mode sequence (see also chapter 6.2.10)
P2.2.5.27 Bit 0 of encoded position selector
P2.2.5.28 Bit 1 of encoded position selector
P2.2.5.29 Bit 2 of encoded position selector

6.2.3.2 Other digital inputs

Calibration sensor used for the calibration cycles (chapter 6.2.8):
P2.2.5.17 CalibrateSensor

Selector for alternative calibration mode:
P2.2.5.32 Calibration Type2

Cam switch for limit stop signals handling (chapter 6.2.4):
P2.2.5.31 Min End Limit
P2.2.5.32 Max End Limit

Selector to enable position control (chapter 6.2.1):
P2.2.5.24 PositCntrEn Sel

Selector to enable automatic positioning mode (chapter 6.2.10)
P2.2.5.25 Automatic mode

6.2.3.3 Position and Home speed and acceleration/deceleration from analogue input

Alternatively to the fixed setting through parameters, Position and Home commands, positioning speed and acceleration/deceleration can be modulated by analogue input. For this purpose the following parameter is used:
P2.8.7.10 Speed Reference

0 Speed and acc/dec from parameters
1 Speed and acc/dec from analogue input AI1
2 Speed and acc/dec from analogue input AI2

Note: The full scale range of analogue input corresponds to the value set with the parameters *P2.8.5 Max Speed* and *P2.8.6 Max Accel.*

Note: The analogue value to calculate speed and acceleration/deceleration for the command execution is read and stored at the beginning of the mission execution, subsequent variations during the execution of the command have no effect. See Figure 6.

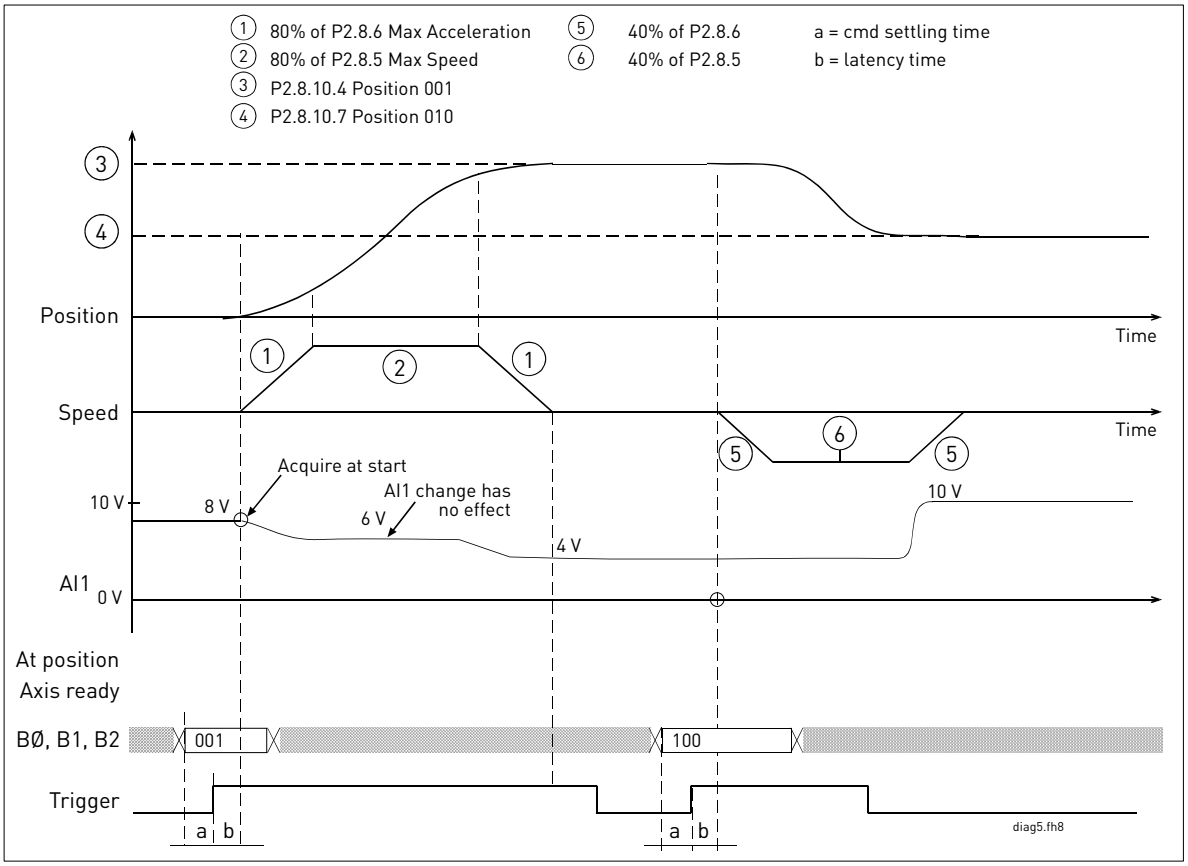

Figure 6. "Go to position" command with speed, acceleration and deceleration modulated with analogue input AI1 (0-10V).

6.2.4 The command sequencer: limit switch handling

After the calibration cycle, the position controller limits the positioning area within the boundaries defined by *P2.8.7.2 Minimum position* and *P2.8.7.1 Maximum position* and rejects position commands (also those coming from fieldbus) with position argument not included in this range. To avoid accidents during jog operations before calibration cycle, or to limit the positioning area of the axis also after the calibration (for example for maintenance) one or two limit stop inputs can be activated (minimum and maximum).

6.2.4.1 Minimum limit stop (digital input programmed by P2.2.5.31/P2.2.5.32)

If the axis runs over the minimum limit stop, a warning W63 "Min Limit Stop" occurs and the axis stops immediately. Possible to run in forward direction

6.2.4.2 Maximum limit stop (digital input programmed by P2.2.5.33/P2.2.5.34)

If the axis runs over the maximum limit stop a warning W64 "Max Limit Stop" occurs.
Possible to run in reverse direction

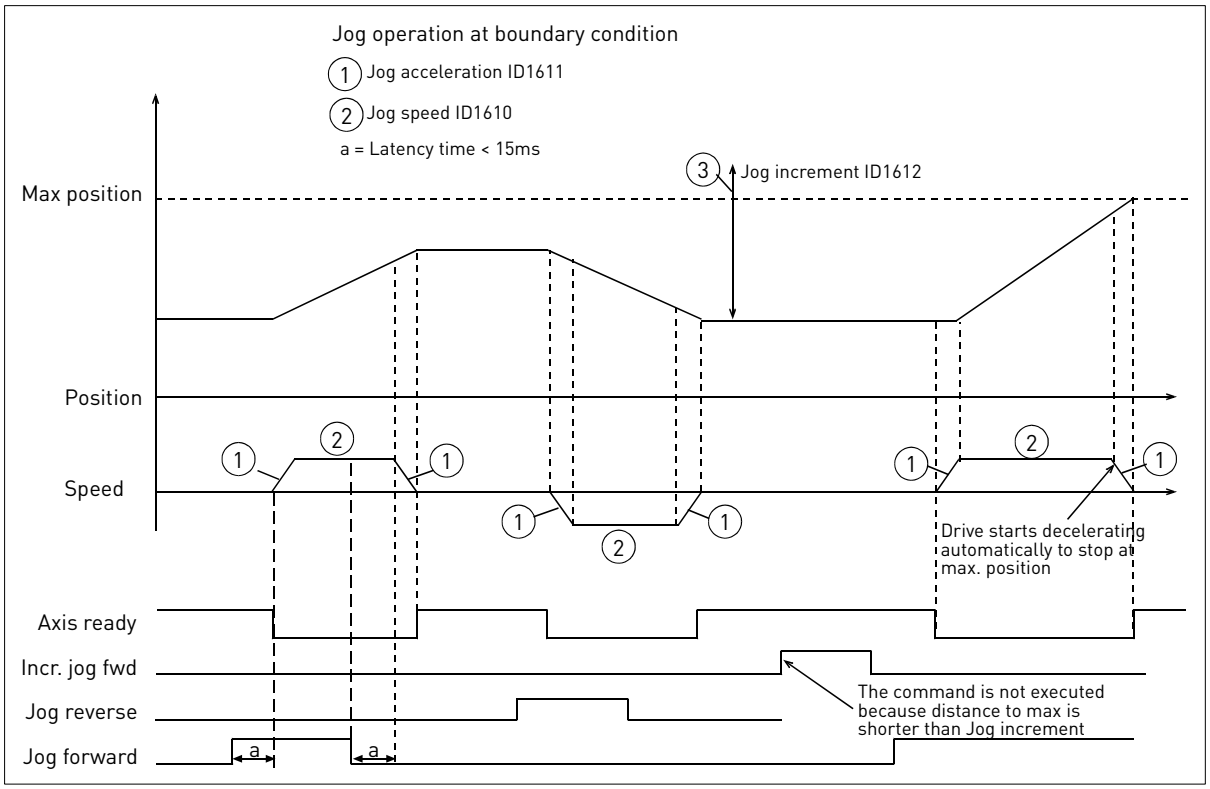

Figure 7. Jog operation at boundary condition

6.2.5 User unit definition and dimensioning considerations

Specification unit for axis distance in user unit is defined by two parameters that describe the ratio between the axis displacement in the preferred unit *(P2.8.3 Distance)* and the corresponding number of turns of the shaft on which the encoder used for position control is mounted *(P2.8.4 Turns)*. The distance unit can be linear or angular. The choice of the unit is affected by the accuracy and dynamic optimization required for the specific application.

The maximum value of the motor frequency constrains the choice of the maximum speed: maximum speed, limited by parameter P2.8.5, can not exceed the value which corresponds to the maximum frequency set for the motor P2.1.2, minus an appropriate dynamic margin (usually 5%, higher values for more "dynamic" applications).
Maximum value for *P2.8.5 Max Speed* can be calculated as follows:

$P2.8.5 = (k_{din} \times P2.1.2 \times 2 / p \times \tau) \times P2.8.3 / P2.8.4$

Where:
P2.8.5 = axis maximum speed [u/s]
k_{din} = 0.9... 0.95 dynamic margin factor. Value 0.95 allows a margin of 5% and is sufficient for most applications.
P2.1.2 = Max frequency [Hz] (margin for motor slip is accounted for by the controller internally)
p = number of poles of the motor
τ = gear ratio between encoder turns and motor turns (encoder turns/motor turns).

Note: If the encoder is directly coupled to the motor *(P2.8.2 Encoder selection = 0/Enc1 motor), τ = 1.*

Maximum acceleration has a physical limit which depends on the ratio between the maximum torque given by the motor ("breakdown" limit for high frequencies or maximum current of frequency converter for lower frequencies) and total inertia reflected to the motor shaft. Maximum value for *P2.8.6 Max Acceleration* in order not to exceed such limit can be calculated as follows:

$P2.8.6\ [u/s^2] = (C_{max} / J_{tot}) \times 2 \times \pi \times \tau \times P2.8.3 / P2.8.4$

Where:
C_{max} = maximum available torque
J_{tot} = inertia on motor shaft (motor side total equivalent inertia)
π = 3.1415926...
τ = gear ratio between encoder and motor

Beyond this value, the motor will not track the speed reference and the position control trips with a F61 fault, *Dynamic position error* (see chapter 6.2.9).

The acceleration time [s] at maximum speed, depending on maximum acceleration, can be calculated as:
T acc [s] = speed [u/s] / acceleration[u/s^2] = P2.8.5 / P2.8.6.

WARNING:
In the resolution selection, the following relation must be verified:
(P2.8.3 Distance / P2.8.4Turns) ≥ K.
For high dynamic applications, the recommended minimum value of the ratio is:
(P2.8.3 Distance / P2.8.4Turns) ≥ 20
For high accuracy, low speed applications the recommended minimum is:
(P2.8.3 Distance / P2.8.4Turns) ≥ 100

Upper numerical limits for *P2.8.5 Max Speed* (max. = 18101 u/s) and for *P2.8.6 Max Acceleration* (max. = 25500 u/s^2) can be a constraint when a very high resolution is defined (high value of K), although the speed limit calculated by (6.2.5-1) and the acceleration limit calculated by (6.2.5-2) are not reached.
On the other hand, the smaller the selected unit (resolution) is, the better is the absolute position accuracy (within mechanical limits).

A limit to resolution/accuracy comes also from the numerical position range, which cannot exceed 55000 units (5000 to 60000).

Example: consider an axis driven by a 50 Hz 4 pole motor, through a 2 mm screw. The total positioning length is 0,3 m = 300 mm. The accuracy required is ± 0,1 mm. An encoder directly coupled to the motor is employed.

Case A: high dynamic solution.
Choose the maximum possible resolution value, that is equal to the error half band, namely 0,1 mm.
The number of distance units for driving area is:
300/0,1 = 3000 u.
The corresponding number of turns is 300/2= 150.
Set P2.8.3 Distance =3000 ; P2.8.4 Turns =150.
The relation (6.2.5-3) is fulfilled.
Starting from (6.2.5-1), with P2.1.2=50 Hz and k_{din} = 0.95, the maximum speed results 475 u/s.
Considering 50 ms as the physical limit to accelerate from zero to maximum speed, the maximum acceleration P2.8.6 must be limited to:
(475 u/s)/0.05s = 9500 u/s^2.

Case B: solution with high precision of motion profile (also at low speed)
Choose a resolution one decade lower that the accuracy required, namely 0,01 mm.
The number of distance units for the driving area is:
300/0,01 = 30000 u.
The number of turns, as in case A, is 300/2= 150.
Set P2.8.3 Distance =30000 ; P2.8.4Turns =150.
Besides (6.2.5-3) the relation (6.2.5-4) is also fulfilled.
Starting from (6.2.5-1), with P2.1.2=50 Hz and k_{din} = 0.95, the maximum speed results 4750 u/s.
Considering 50 ms as the physical limit to accelerate from zero to maximum speed, the maximum acceleration P2.8.6 must be limited to:
(4750 u/s)/0.05s = 95000 u/s^2.
As the numerical limit is 25500 u/s^2, the drive reaches its maximum speed in 186 ms. In this case, the numerical limit is more restrictive than the physical limit. In other words, setting P2.8.6 to 25500 u/s^2 the drive accelerates in 186 ms.

6.2.6 The command sequencer: "mission" supervision

The sequence of operation that carries out a position command is defined a "mission". When a mission is executed, the following supervision operations are performed:

- Dynamic error monitoring, "fault" 61 (*Dynamic position error*) occurrence in case of corresponding limit overriding
- *V1.21 Actual position monitoring* (measured with encoder and turned into axis units), *V1.20 Position reference monitoring* (generated by the trapezoidal interpolator), *V1.22 Position error monitoring*. All these values are reached through keypad (menu M1) and fieldbus.
- Status register and signalling update

The end of the mission is notified by digital outputs (Axis ready, In Position, At Home) or fieldbus (status register). When the mission is finished, the following supervision operations are performed:

- Static error monitoring, "fault" 62 (*Static position error*) occurrence in case of corresponding threshold limit overriding
- *V1.21 Actual position*, *V1.20 Position reference* and *V1.22 Position error monitoring* (as above mentioned).
- Status register and signalling update

Note: Even with the position control not enabled or drive not running, the reading of the actual position V1.21 will be in any case updated. After a power down, the calibration cycle must be repeated. To avoid this, an external backup 24V supply should be fed to the control terminals so that position data is preserved even if the power unit is disconnected (emergency, protections trip, etc). Observe wiring requirements specified in NX frequency converter user manual (interlock diode, etc).

6.2.7 The command sequencer: Fieldbus interface

Position control can be enabled in three different and mutually exclusive ways (not concurrently used):
From parameter P2.8.1 PosControllerEn = 1
From digital input, with P2.8.1 PosControllerEn = 0 and digital input selected with P2.2.5.24 PositCntrEn sel
From fieldbus, with P2.8.1 PosControllerEn = 2 and writing 1 on bit 15 of the command register (see Table 33).

The predefined control and status words of the specific fieldbus profile in use (or the native control and status words of the drive if using "Bypass mode") are used to operate drive RUN, STOP and Fault reset, and supervise generic operating conditions. Predefined "Reference" channel is not used when position control is active. The process data must be configured and used for position control as follows:

Process data in (master to follower)
P2.9.9 to configure a channel for Command register for position control (Table 33), default is PD1
P2.9.10 to configure a channel for Positioning speed [u/s], default is PD2
P2.9.11 to configure a channel for Positioning acceleration [u/ss], default is PD3
P2.9.12 to configure a channel for Position [u], default is PD4
P2.9.13 to configure a channel for Positioning deceleration [u/ss], default is none.

Note: If Positioning deceleration channel is not configured, the value from Acceleration channel is used also for deceleration.

Process data out (follower to master)
All process data out are programmable as shown in chapter 6.4. The default setting is listed below:

PD1 = status register for position control (Table 6-3)
PD2 = position reference [u]
PD3 = actual position [u]
PD4 = position error, signed [u]
PD5 = speed of the motor measured with encoder [Hz]
PD6 = motor current (resolution is size depending, 1 unit = 0.01 A or 0.1 A or 1 A. The value V1.4 in Monitor Menu has the same resolution)
PD7 = torque (positive torque = torque acting in the positive direction of the axis coordinate,; 1 unit = 0.1% of nominal motor torque)
PD8 = Last active fault or warning code

bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8
Enable Position control	Reserved	Reserved	Reserved	Reserved	Reserved	Trigger for automatic cycle	Mode Sel.: 0=normal 1=automatic cycle

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
Position 2	Position 1	Home	Incremental Jog reverse	Incremental Jog forward	Jog reverse	Jog forward	Calibration Cycle

Table 33: Command register for position control

For convenience, two bits for position command, 6 and 7, are available in the command register. In case of permanent commands, the bit must be held on up to the completion of the mission. Two bus cycles (write 0 and write 1) would be needed to generate the positive edge required to issue a new

position command if only one bit was available. With two bits, a single write cycle can be used to clear one bit and set the other to generate a new command. This may save time for the case of time-critical applications.

Position control activation through bit 15 in the command register can be used instead of the one by digital input (do not use them concurrently) and requires the setting of P2.8.1 PosControllerEn=2. The automatic cycle selection and the trigger for its activation (bits 8 and 9) enable the Automatic cycle as shown in chapter 5.9.5.

Note: When the automatic cycle is used, the arguments for automatic cycle commands are not those written on process data channels, on the contrary, they are the values of the relative parameters. The "manual", or individual commands defined by bits 0 to 7, that use arguments from process data channels, are enabled only when parameter P2.8.11.2 EnManualCommands = 1.

The execution of the commands starts with the transition of the relative bit in the command register. The values of speeds, acceleration and position must be valid in such instant and are memorized. The command bit must be set to zero before or at the same time in which the bit for the next command execution is set.

Note: Also for fieldbus interface, parameter P2.8.7.9 determines impulsive or permanent logic for command bits. Anyway no command is accepted until the execution of the mission concerning the previous command is finished.

bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8
Command status: 00=ready(intial status) 01=executing 10=aborted 11=completed		Reserved	1 = Axis ready	1 = Axis in motion	1=Calibration cycle done	1=Position regulator active	Mode Sel.: 0=normal 1= Autom. cycle

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
Position 2	Position1	Home	Incremental Jog reverse	Incremental Jog forward	Jog reverse	Jog forward	Calibration

Table 34. Status register for position control

The bits from 0 to 7 are the state "flags" of commands. Only one of them at a time can be "high" (value 1). This is set to 1 when the execution of the relative command starts. The field "Command Status" refers to the command whose "flag" is high. The flag of a command is reset when the execution of another command starts.

Note: Axis Ready = 1 means that the axis is not in motion and is ready for the execution of commands. This condition can be different from Axis in Motion = 0. The latter can be temporarily true during the execution of a complex command (Home), while the first is true only when the execution of a command is finished.

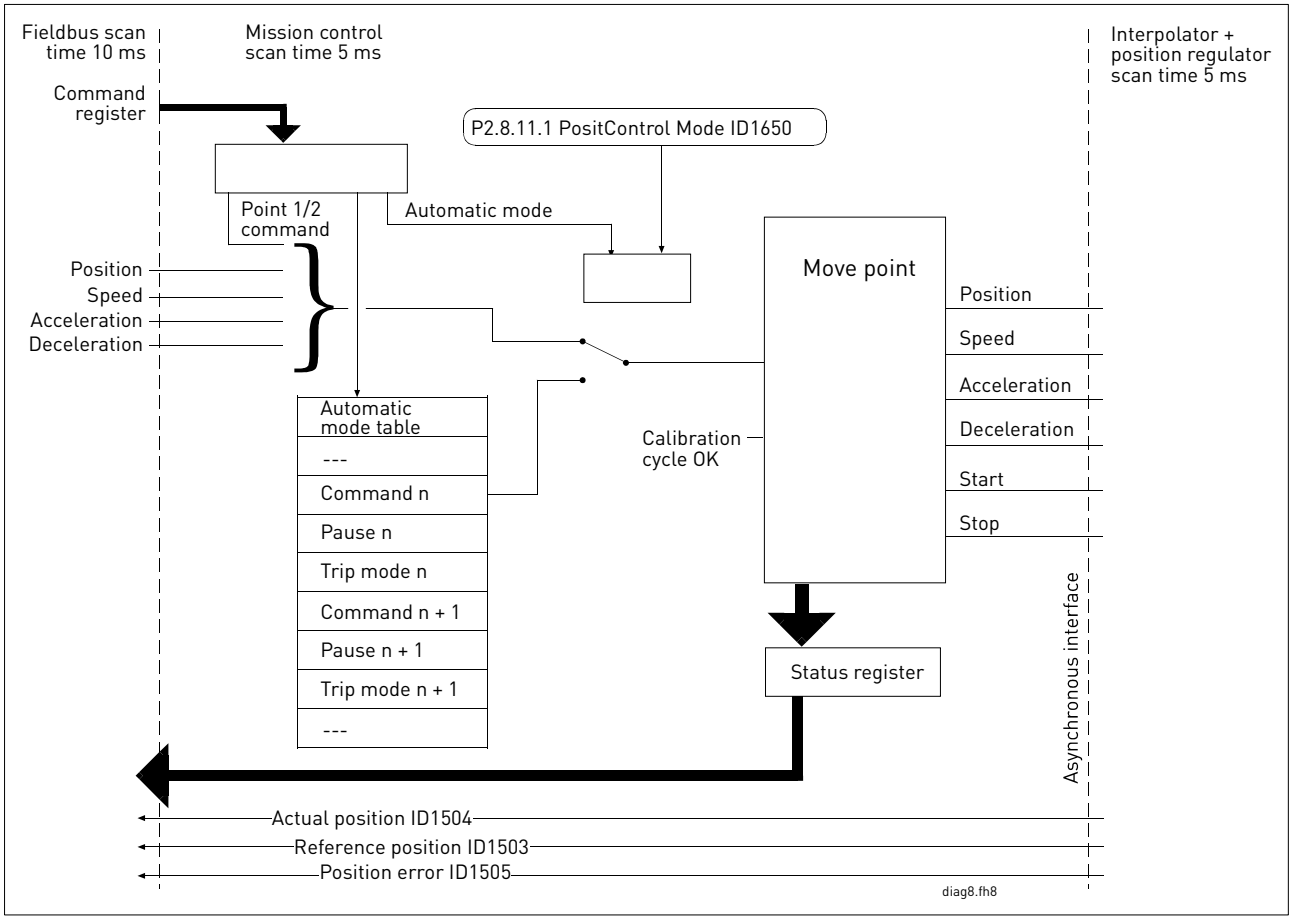

Figure 8. Position 1; Block diagram "Position mission control with fieldbus interface"

6.2.8 The command sequencer: Calibration mode

There are several types of calibration cycles available, suitable for different applications. This function is selected with parameter *P2.8.8.1 CalibrationType1*. It is possible to select an alternative calibration mode specified by parameter *P2.8.8.8 Calibration Type 2* by means of a digital input configured with parameter *P2.2.5.30 CalibrationType 2*.

6.2.8.1 Type 0

Manual calibration setting. The Calibration offset coordinate (P2.8.8.4) is assigned to axis *Actual position (V1.21)*. Prior to issuing this command, the axis shall be driven to the required position either using the jog command or even manually. The command is accepted also with the drive in STOP state.

6.2.8.2 Type 1

Calibration useful for repeated incremental motion of a circular axis in the same direction (eg. Rotating platforms). The Offset coordinate P2.8.8.4 is assigned to axis *Reference position (V1.20)*. Assignment to the reference position avoids accumulation of numerical truncation errors resulting in drift of axis position. This calibration method is equivalent to a strictly integer coordinate translation.

6.2.8.3 Types 2 and 3

Calibration based on the reading of the encoder Z-pulse.
The searching direction is positive (increasing coordinate) for type 2 (Figure 9), negative for type 3. This method gives a very accurate calibration position independent of calibration speed. The method can be used when the total calibration movement is within 1 encoder turn (360° rotation table). Calibration speed P2.8.8.2 is used.

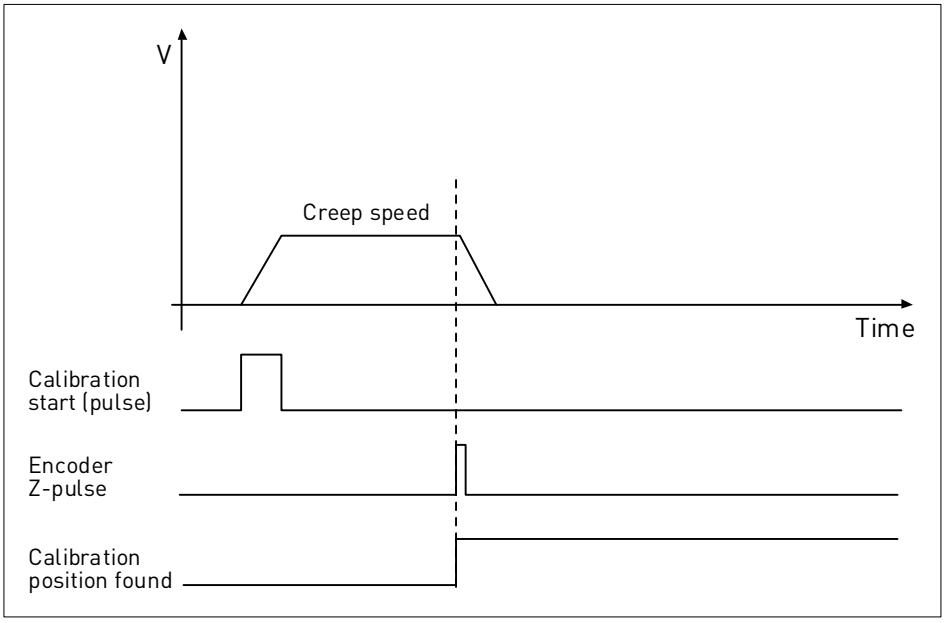

Figure 9. Timing diagram for methods 2 and 3

6.2.8.4 Types 4 and 5

Calibration based on digital input *P2.2.5.17 Calibrate Sensor*, with sequence of backlash compensation.

- Start searching for the calibration sensor input with calibration high speed P2.8.8.3, the searching direction is positive for type 4, negative for type 5.

- Stops when the calibration sensor goes high.
- The axis reverses its direction and uses the calibration (low) speed P2.8.8.2 and establishes the calibration position when the sensor signal goes low (falling edge)
- If initial state of the calibration sensor is high the start searching direction is opposite with calibration low speed P2.8.8.2, and calibration position is always associated with falling edge, so that the mechanical backlash acts always in the same direction and repetitivity error is minimized.

For this type of calibration, the calibration speed P2.8.8.2 must be limited in order to minimize the measuring error due to digital input software sampling at a 5 ms rate.

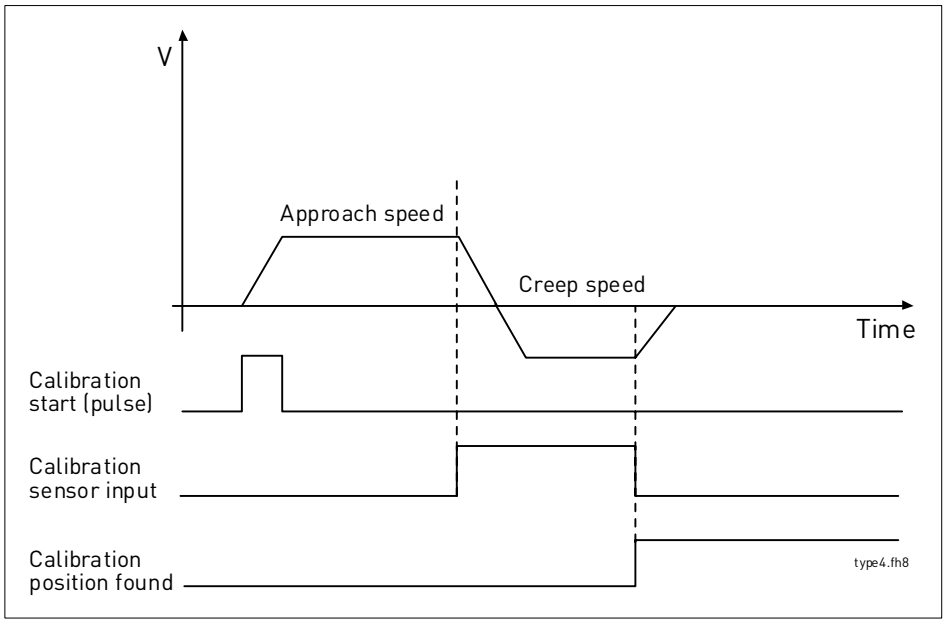

Figure 10. Timing diagram for methods 4 and 5

6.2.8.5 Types 6 and 7

Calibration based on digital input parameter *P2.2.5.17 Calibrate Sensor*, without sequence of backlash compensation.
Start searching for the calibration sensor input with *Calibration speed P2.8.8.2*. The searching direction is positive for type 6, negative for type 7. Calibration position is taken on the calibration sensor rising edge.
On the contrary, if at first the switch is closed, the searching direction is opposite and the calibration position is is taken on the calibration sensor falling edge.
The input for the calibration sensor used can be selected with parameter *P2.2.5.17 Calibrate Sensor*.
For this type of calibration, the calibration speed P2.8.8.2 must be limited in order to minimize the measuring error due to digital input software sampling at a 5 ms rate.

Note: The procedure can take a long time to perform if the positioning unit is far away from the calibration sensor at start. Better use method 4 or 5 if possible.

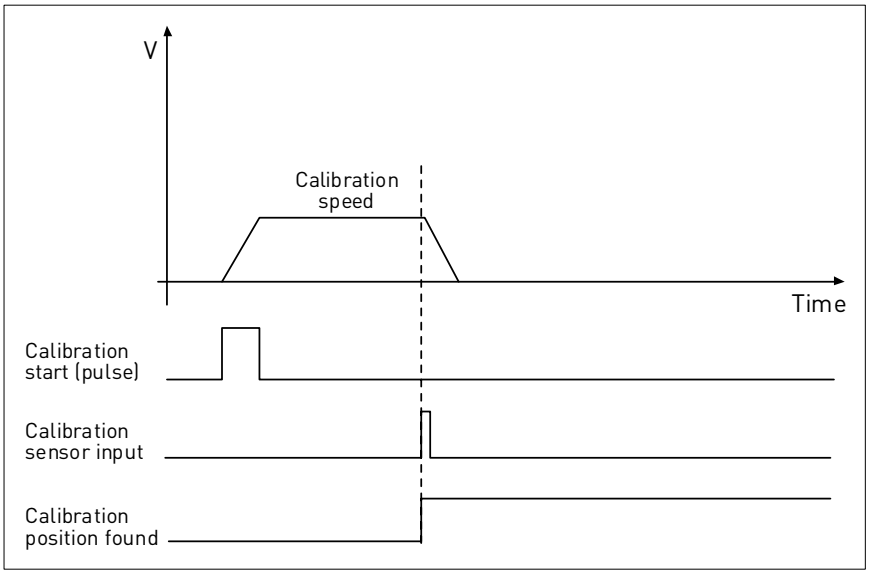

Figure 11. Timing diagram for methods 6 and 7

6.2.8.6 Types 10 and 11 (Not supported, reserved for future)

Calibration based on Calibration sensor + Encoder Z-pulse.
The signal of the calibration sensor must be connected to a digital input that can be selected with parameter *P2.2.5.17 Calibrate sensor*. Furthermore, it must be connected to the dedicated input ENC1Q of the encoder board (see Figure 13). Starting with low signal from the calibration sensor, the searching direction is positive for type 10 (Figure 12), negative for type 11. The calibration position is taken at the first rising edge of Z-pulse AND when the calibration sensor signal (ENC1Q) is high.
On the contrary, if the signal from the calibration sensor is high at start, the motion direction is negative for type 10, positive for type 11, until the calibration sensor signal goes low, at this point the direction is reversed and the calibration position is determined as described above.

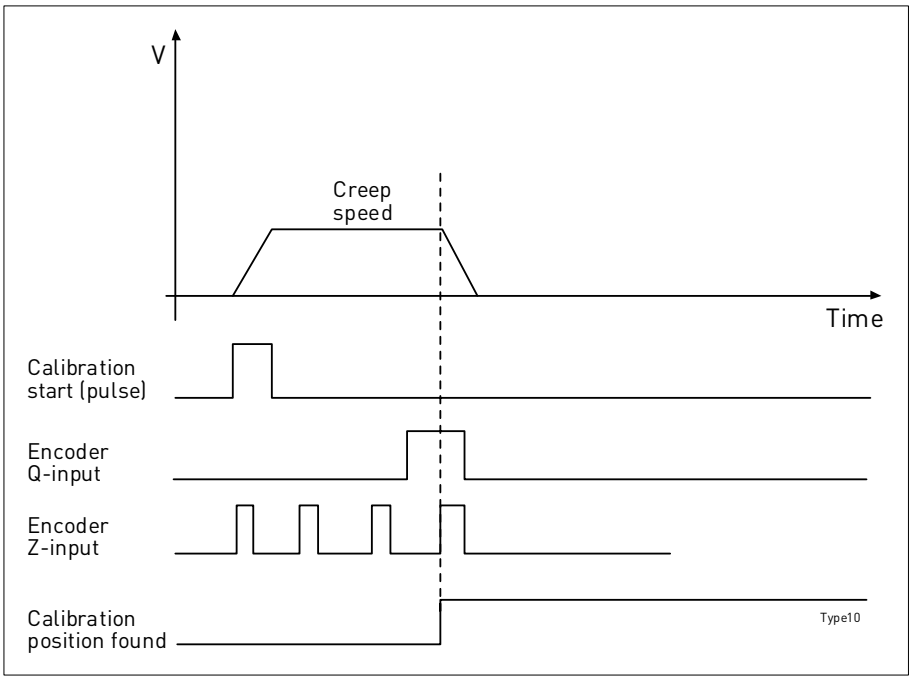

Figure 12. Timing diagram for methods 10 and 11

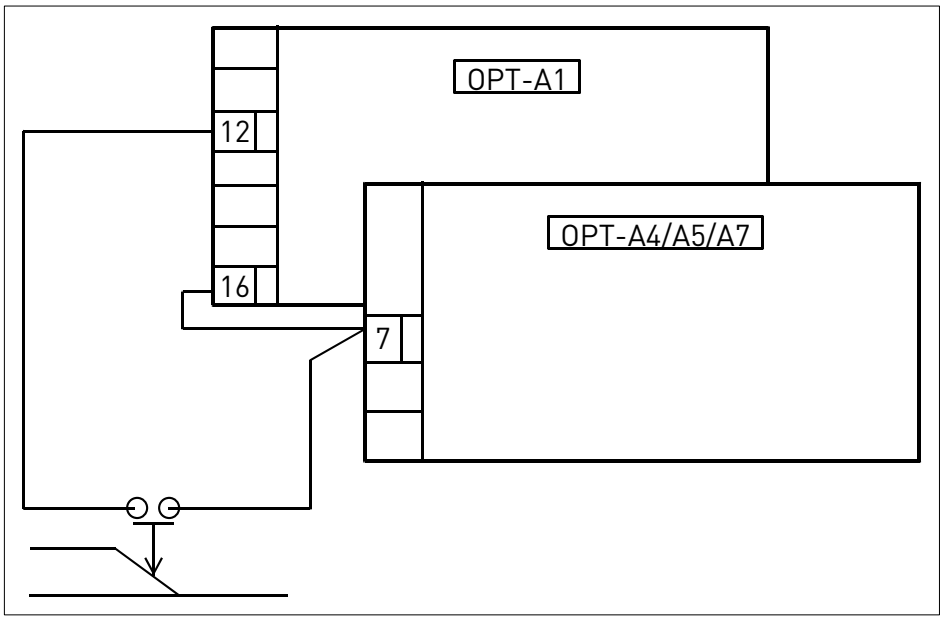

Figure 13. Example of calibration sensor input wiring

6.2.9 The regulator

In the regulator section (Figure 14) an interpolator block provides the speed profile necessary to generate the positioning mission. Such profile is trapezoidal, (namely with linear ramp and constant speed) and usually symmetric, in other words, the deceleration ramp has the same slope as the acceleration one (an asymmetrical profile can be obtained through fieldbus using deceleration channel). The acceleration time can be calculated as follows: T acc [s] = speed [u/s] / acceleration [u/s^2].
Note: Acceleration times used in speed control (P2.1.3, P2.1.4) do not affect the position control.

The position reference trajectory is generated by the interpolator by discrete integration of the speed profile. The position reference is then tracked by a proportional regulator that generates the necessary speed reference for the drive.
The end of the mission is determined when the reference position equals the target position. A tolerance for end of mission detection may be defined with P2.8.7.4 TargetDelta (default =0). During mission execution, the block "Error supervisor" controls that the position error does not exceed the value determined by *P2.8.7.7 Dynamic error*, where a "Fault" *F61 Dynamic Position Error* is generated and the mission is stopped immediately.
When the mission is completed, after the time determined by parameter *P2.8.7.6 Settling Time* has expired, the "Error supervisor" checks that the position error does not exceed the value determined by *P2.8.7.5 Static Error*, where it generates a "Fault" *F62 Static Position Error*.
The "Controller" block develops the proportional adjustment of position providing the frequency reference according to position error signal. The gain is adjustable with parameter P2.8.7.3. The position control requires closed loop speed control (P2.5.1=3 CL Speed). For the optimization of the position control first of all speed controller must be optimized (P2.5.14.2, P2.5.14.3).

Note: In case of any fault, including dynamic distance error, the position control is disabled and the drive stops using the ramp defined by P2.1.4 (or by coast for time critical faults). Therefore P2.1.4 Deceleration time should be tuned to achieve the required stop distance in case of fault.

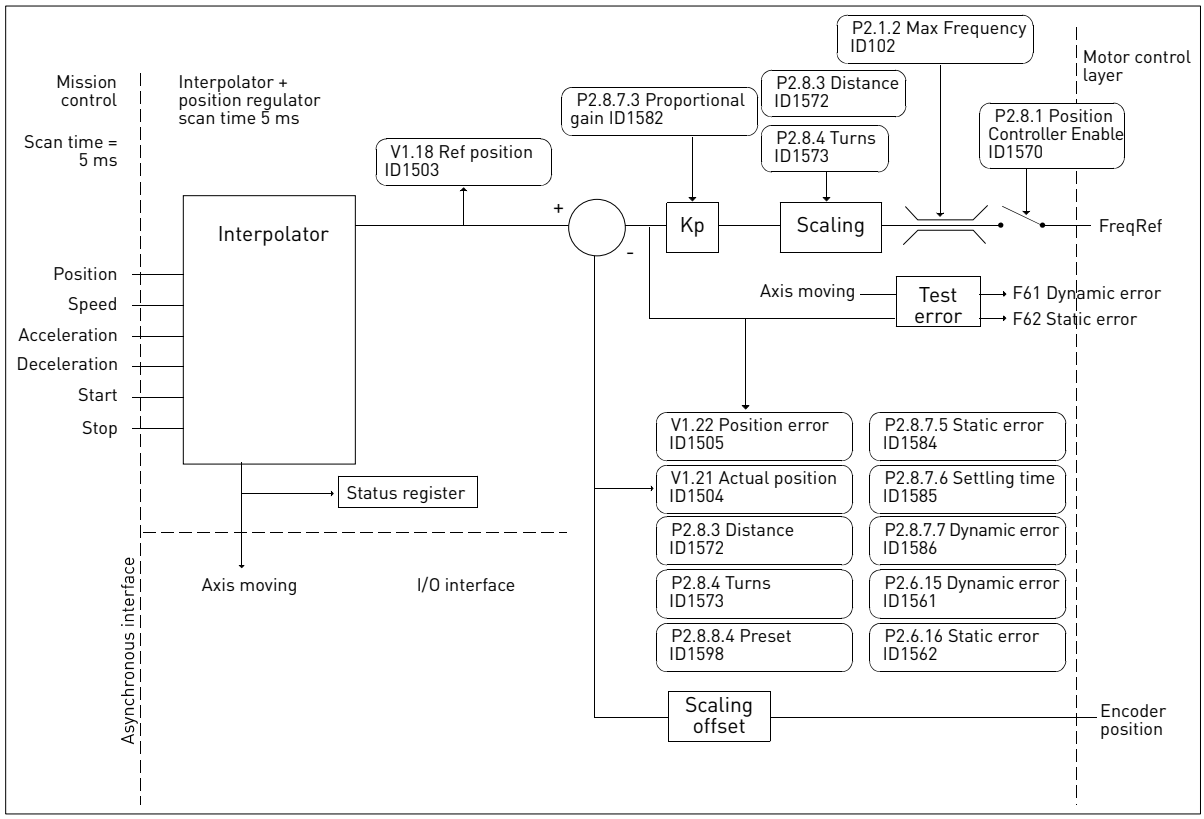

Figure 14. Position interpolator/regulator block diagram.

6.2.10 Special function: Automatic cycle

The automatic cycle is used to operate a pre-defined sequence of commands controlled by one or more trigger pulses.
There are three different ways to enable it (which cannot be used concurrently):

- Parameter *P2.8.11.1 Posit Control Mode* = 1 automatic cycle
- Digital input, with an high level on relative input *P2.2.5.25 Automatic Enable*
- Fieldbus, writing 1 on bit 8 of the command register (see Table 33).

It is possible to define a command sequence up to a maximum of 6 steps, with dwells time that can be programmed between one command and the following one.The next step can be trigged automatically (after dwell time) or by trigger input. Each single command from the sequence can be selected among the following ones:

Position 000 to Position 111, incremental Jog forward, incremental Jog reverse, Home.
Command parameters are the same as used when the programmed command is performed separately (also when the sequence is controlled from the fieldbus). A digital input is used as trigger, and it can be selected through *P2.2.5.26 Trigger Input* or via fieldbus as bit 9 in the command register.

Note: Trigger pulse duration must exceed the minimum of 20 ms.

With the drive running and the position controller enabled, the sequence must be always started by a "trigger". After each command, a dwell can be programmed (from 0.0 to 10.0 s), during which the trigger pulses that might occur are ignored.
The subsequent command or the repetition of the sequence may be conditioned to a new trigger pulse, through a Trigger Mode parameter which can undertake value *Auto* (after the dwell the subsequent command is carried out unconditionally) or value *Normal* (the subsequent command is carried out with the arrival of a new trigger pulse).
The first command not programmed is considered as the end of the sequence. In such case the execution must be restarted from the first command.
Trigger pulses during the execution of a command or the relative dwell are ignored.
Setting the trigger input selector to "DigIn:0.2", namely forcing the input to TRUE state, the trigger is considered always active, in this case as soon as a drive RUN command is given, the sequence will start.
Mixed cycles can be defined where a number of commands are performed in sequence (trigger auto), and others are conditioned by an impulse (trigger normal).

Example: Shear

Parameter	Value
P2.8.1 PosControllerEn	1/Enabled
P2.8.7.8 Calib. On Home	1/Yes
P2.8.8.1 CalibrationType1	7/Cam reverse
P2.8.11.1 Posit Control Mode	1/Automatic cycle
P2.8.11.2 EnManualCommands	1/Yes
P2.8.11.3 First command	1/Position 000
P2.8.11.4 Pause 1	0.0 s
P2.8.11.5 Trig Mode 1-2	1/Auto
P2.8.11.6 Second command	5/Home
P2.8.11.7 Pause 2	0.0 s
P2.8.11.8 Trig Mode 2-3	0/Normal
P2.8.11.9 Third command	0/No command

Table 35.

Through a manual command, the axis is carried out to zero (manual commands are enabled by P2.8.11.2 = 1). The trigger pulse controls the cutting stroke (P2.8.11.3 = Position 000) and immediately after (with no dwell, P2.8.11.4 = 0, and without a new trigger pulse, P2.8.11.5 = 1 Auto) the axis is carried out to zero and repositioned to start the next cutting stroke sequence (P2.8.11.6=5 requires homing and P2.8.7.8 = 1 forces repetition of calibration cycle prior to homing). The sequence is finished because P2.8.11.9 = 0. The subsequent cutting stroke depends on a new trigger pulse because P2.8.11.8 = 0 Normal (on trigger front the execution is redirected to the first command of the new cycle as the third command has not been programmed).

6.3 Fieldbus configuration

The input process data (master to follower) configuration is controlled by parameters P2.9.9 to P2.9.15. For each reference signal the desired data channel is allocated. References to be configured are:

P2.9.9 Position command register
P2.9.10 Speed for positioning
P2.9.11 Acceleration for positioning
P2.9.12 Position argument
P2.9.13 Deceleration for positioning (deceleration is same as acceleration if this is not used)
P2.9.14 Torque reference (this can be used for torque control mode with position control disabled)
P2.9.15 Free signal (this can be used for current or torque limiting according to functionality of the Multipurpose application)

See chapter 6.2.7 for process data description. All Process data out (follower to master) are programmable through 8 parameters, from P2.9.1 to P2.9.8. Through these parameters, it is possible to monitor any variable from the fieldbus. The list of the variables, with resolution or bits map indication, is in Table 36. The variable selection can be done setting the ID number ("identifier") of the item you wish to monitor to the parameter selector. The default parameter selectors are the following:

- PD1 = status register of position control(Table 6-3)
- PD2 = position reference [u]
- PD3 = actual position [u]
- PD4 = position error, signed [u]
- PD5 = motor speed measured with encoder (in electric Hz, depending on poles number of the motor, 1 unit = 0.01 Hz)
- PD6 = motor current
- PD7 = Torque in CL
- PD8 = Last warning or fault code

Variable	Resolution	Unit	ID	Description
Output frequency	0.01		1	Output frequency to the motor
Frequency reference	0.01		25	Frequency reference to motor control
Motor speed	1	Rpm	2	Motor speed in rpm
Motor current	0.01, 0.1, 1	A	3	Output current, rms, size depending
Motor torque	0,1	%	4	In % of nominal motor torque
Motor power	0,1	%	5	Motor shaft power, in % of motor nominal power
Motor voltage	0,1	V	6	Motor voltage, rms
DC link voltage	1	V	7	Measured DC link voltage
Unit temperature	1	°C	8	Heatsink temperature
Analogue input 1	0,01	V/mA	13	AI1
Analogue input 2	0,01	V/mA	14	AI2
DIN1, DIN2, DIN3			15	Digital input statuses: bit 0 = DigIN:A.3 bit 1 = DigIN:A.2 bit 2 = DigIN:A.1 bit 3-15 = 0
DIN4, DIN5, DIN6			16	Digital input statuses: bit 0 = DigIN:A.6 bit 1 = DigIN:A.5 bit 2 = DigIN:A.4 bit 3-15 = 0
Analogue output	0,01	mA	26	AO1
ID Run Status			49	Status of identification run made
Pole pair number			58	Pole pair number calculated based on given motor data
Pos. Control Active			1500	1=position control enabled
Axis in Motion			1501	1=Axis running
Calib cycle Done			1502	1=zero setting performed
Pos. Reference	1	U	1503	Position reference in unit-axis
Current Position	1	U	1504	Current position in unit-axis
Positioning error	1	U	1505	Position error in unit-axis
PositContFreqRef	0,01	Hz	1506	Freq. Ref. generated by position control
Encoder 1 Freq	0,01	Hz	1124	Encoder speed 1 in electric Hz, filtered by Enc1FiltTime
Encoder 2 Freq	0,01	Hz	53	
Torque mode CL	0,1	%	1510	Torque generated in open loop control
Torque ref. mode 3	0,1	%	1511	Torque ref. In closed loop speed control
Torque ref. mode 4	0,1	%	1512	Torque ref. In closed loop torque control
History fault			37	Last Warning or Fault code
Digital inputs A.1-A.6			1513	Digital input statuses bit 0 = DigIN:A.1 bit 1 = DigIN:A.2 bit 2 = DigIN:A.3 bit 3 = DigIN:A.4 bit 4 = DigIN:A.5 bit 5 = DigIN:A.6 bit 6-15 = 0
Pos Status Register			1514	Status register of position control

Table 36. Variable selection for process data out

6.4 SystemBus configuration

The use of SystemBus requires usage of the option board OPT-D1 or OPT-D2, see description in chapter 0.
In this application, the SystemBus is used only for the transmission of a speed reference from a drive master to a drive follower through the process channel PD1. Parameter P2.10.1 *System Bus Mode* must be set to 3 for the master or to 2 for the follower or left to 0 when not in use. The other values are only meant for future use.

Communication speed and node number is set up for used system bus card in the expander board menu M7. Also remember to set the Next ID for next node on the system bus.

The master drive parameter P2.10.2.1 *Master Output* allows the selection of the reference signal that will be transmitted.
For the follower drive, parameters P2.10.3.1 and P2.10.3.2 allow to apply reference scaling. The reference coming from System Bus can be selected as the active speed reference setting parameters P2.1.12 or P2.1.13 or P2.1.14 to value 2, depending on which is the active "control place".

7. DESCRIPTION OF STANDARD PARAMETERS

On the following pages you will find the parameter descriptions arranged according to the individual ID number of the parameter. A shaded parameter ID number (e.g. *418 Motor potentiometer UP*) indicates that the *TTF programming method* shall be applied to this parameter.

102 *Maximum frequency*

Defines the frequency limits of the frequency converter.
The maximum value for these parameters is 320 Hz.
The software will automatically check the values of parameters ID105, ID106, ID315 and ID728.

103 *Acceleration time 1*
104 *Deceleration time 1*

These limits correspond to the time required for the output frequency to accelerate from the zero frequency to the set maximum frequency (par. ID102).

105 *Preset speed 1*
106 *Preset speed 2*

Parameter values are automatically limited between the minimum and maximum frequencies (par. ID101, ID102).
Note the use of TTF-programming method in the Multi-purpose Control Application. See parameters ID419, ID420 and ID421.

Speed	Multi-step speed sel. 1 (DIN4)	Multi-step speed sel. 2 (DIN5)
Basic speed	0	0
ID105	1	0
ID106	0	1

Table 37. Preset speed

107 Current limit

This parameter determines the maximum motor current from the frequency converter. The parameter value range differs from size to size. See the table below for the range and the default values of parameters ID107 and ID113 for your converter.

Type	Par. ID107/ID113 (min)	Par. ID107/ID113 (max)	Par. ID107 (default)	Par. ID113 (default)
NX 0003 5	0,70	4,40	3,10	2,20
NX 0004 5	1,00	6,20	4,00	3,10
NX 0005 5	1,30	8,00	5,40	4,00
NX 0007 5	1,70	10,80	7,00	5,40
NX 0009 5	2,2	14,0	9,0	7,0
NX 0012 5	3,1	18,0	12,0	9,0
NX 0016 5	4,0	24,0	16,0	12,0
NX 0022 5	5,4	32,0	22,0	16,0
NX 0031 5	7,0	44,0	31,0	22,0
NX 0038 5	9,0	62,0	38,0	31,0
NX 0045 5	12,0	76,0	45,0	38,0
NX 0061 5	16,0	90,0	61,0	45,0
NX 0072 5	22,0	122,0	72,0	61,0
NX 0087 5	31,0	144,0	87,0	72,0
NX 0105 5	38,0	174,0	105,0	87,0
NX 0140 5	45,0	210,0	140,0	105,0
NX 0168 5	61,0	280,0	168,0	140,0
NX 0205 5	72,0	336,0	205,0	168,0
NX 0261 5	87,0	360,0	261,0	205,0
NX 0300 5	105,0	450,0	300,0	240,0

Table 38. Size-dependent values of parameters ID107 and ID113

108 U/f ratio selection

Linear: **0** The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point where the nominal voltage is supplied to the motor. Linear U/f ratio should be used in constant torque applications. **This default setting should be used if there is no special need for another setting.**

Squared: **1** The voltage of the motor changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening point where the nominal voltage is also supplied to the motor. The motor runs under magnetised below the field weakening point and produces less torque and electromechanical noise. Squared U/f ratio can be used in applications where torque demand of the load is proportional to the square of the speed, e.g in centrifugal fans and pumps.

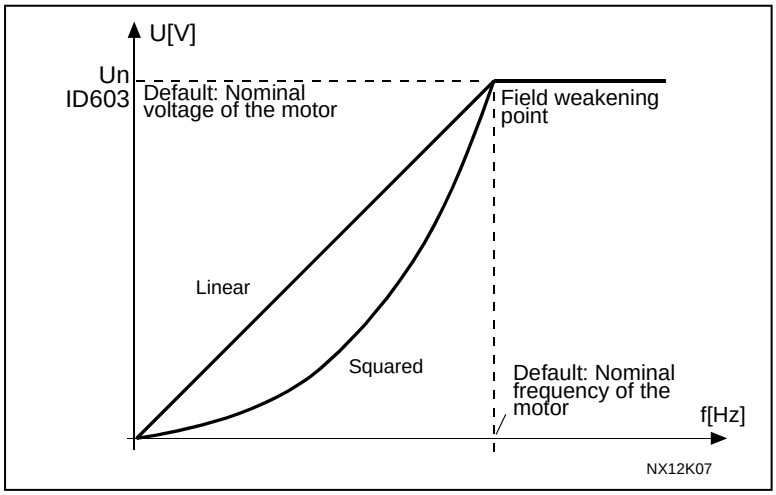

Figure 15. Linear and squared change of motor voltage

Programmable U/f curve:

2 The U/f curve can be programmed with three different points. Programmable U/f curve can be used if the other settings do not satisfy the needs of the application.

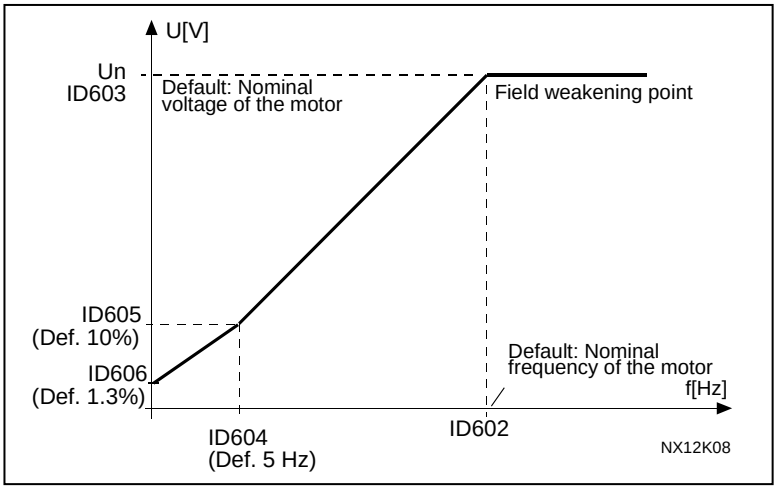

Figure 16. Programmable U/f curve

Linear with flux optimisation:

3 The frequency converter starts to search for the minimum motor current in order to save energy, lower the disturbance level and the noise. This function can be used in applications with constant motor load, such as fans, pumps etc.

109 U/f optimisation

Automatic torque boost The voltage to the motor changes automatically which makes the motor produce sufficient torque to start and run at low frequencies. The voltage increase depends on the motor type and power. Automatic torque boost can be used in applications where starting torque due to starting friction is high, e.g. in conveyors.

EXAMPLE:

What changes are required to start with load from 0 Hz?

- First set the motor nominal values (Parameter group 2.1).

Option 1: Activate the Automatic torque boost.

Option 2: Programmable U/f curve
To get torque you need to set the zero point voltage and midpoint voltage/frequency (in parameter group 2.6) so that the motor takes enough current at low frequencies. First set par. ID108 to *Programmable U/F-curve* (value **2**). Increase zero point voltage (ID606) to get enough current at zero speed. Set then the midpoint voltage (ID605) to 1.4142*ID606 and midpoint frequency (ID604) to value ID605/100%*ID111.

NOTE! *In high torque - low speed applications - it is likely that the motor will overheat. If the motor has to run a prolonged time under these conditions, special attention must be paid to cooling the motor. Use external cooling for the motor if the temperature tends to rise too high.*

110 Nominal voltage of the motor

Find this value U_n on the rating plate of the motor. This parameter sets the voltage at the field weakening point (ID603) to 100% x U_{nmotor}.

111 Nominal frequency of the motor

Find this value f_n on the rating plate of the motor. This parameter sets the field weakening point (ID602) to the same value.

112 Nominal speed of the motor

Find this value n_n on the rating plate of the motor.

113 Nominal current of the motor

Find this value I_n on the rating plate of the motor. See Table 38.

117 *I/O frequency reference selection*

Defines which frequency reference source is selected when controlled from the I/O control place.

Selection	Reference Source
0	Analogue volt.ref. Terminals 2–3
1	Analogue curr.ref. Terminals 4–5
2	AI1+AI2
3	AI1–AI2
4	AI2–AI1
5	AI1*AI2
6	AI1 joystick
7	AI2 joystick
8	Keypad reference (Menu M3)
9	Fieldbus reference
10	Potentiometer reference; controlled with DIN5 (TRUE=increase) and DIN6 (TRUE=decrease)
11	AI1 or AI2, whichever is lower
12	AI1 or AI2, whichever is greater
13	Max. frequency (recommended in torque control only)
14	AI1/AI2 selection

Table 39. Selections for parameter ID117

120 *Motor cos phi*

Find this value "cos phi" on the rating plate of the motor.

121 *Keypad frequency reference selection*

Defines which frequency reference source is selected when controlled from the keypad.

Selection	Reference Source
0	Analogue volt.ref. Terminals 2–3
1	Analogue curr.ref. Terminals 4–5
2	AI1+AI2
3	AI1–AI2
4	AI2–AI1
5	AI1*AI2
6	AI1 joystick
7	AI2 joystick
8	Keypad reference (Menu M3)
9	Fieldbus reference*

Table 40. Selections for parameter ID121

*FBSpeedReference

122 *Fieldbus frequency reference selection*

Defines which frequency reference source is selected when controlled from the fieldbus. For selections, see ID121.

300 Start/Stop logic selection

0 DIN1: closed contact = start forward
DIN2: closed contact = start reverse

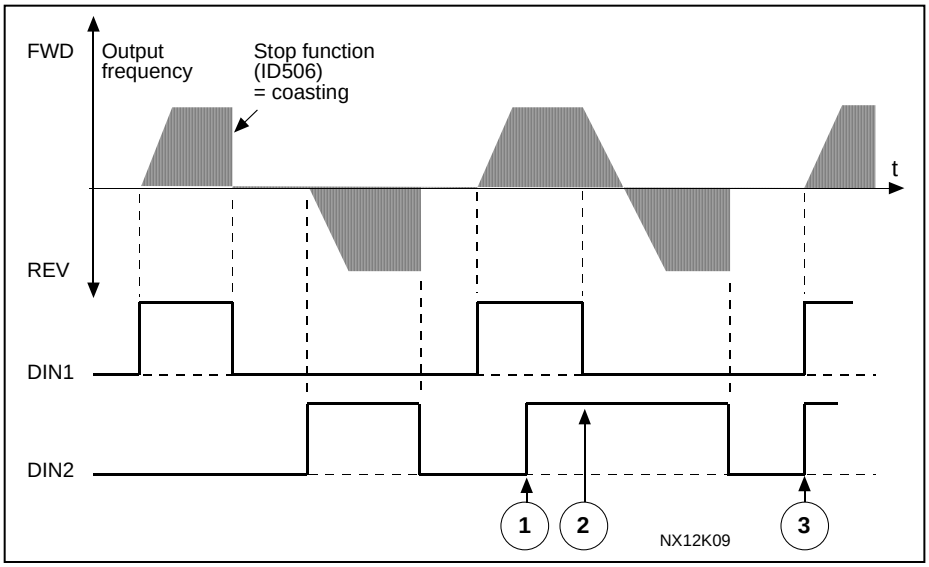

Figure 17. Start forward/Start reverse

① The first selected direction has the highest priority.

② When the DIN1 contact opens the direction of rotation starts the change.

③ If Start forward (DIN1) and Start reverse (DIN2) signals are active simultaneously the Start forward signal (DIN1) has priority.

1 DIN1: closed contact = start open contact = stop
DIN2: closed contact = reverse open contact = forward
See below.

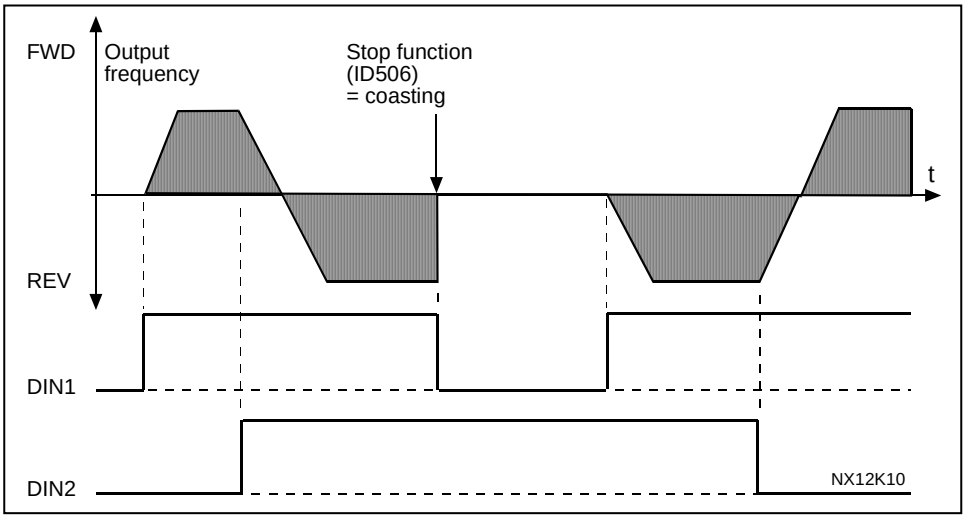

Figure 18. Start, Stop, Reverse

2 DIN1: closed contact = start open contact = stop
DIN2: closed contact = start enabled open contact = start disabled and drive stopped if running

3 3-wire connection (pulse control):
DIN1: closed contact = start pulse
DIN2: open contact = stop pulse
(DIN3 can be programmed for reverse command)
See Figure 19.

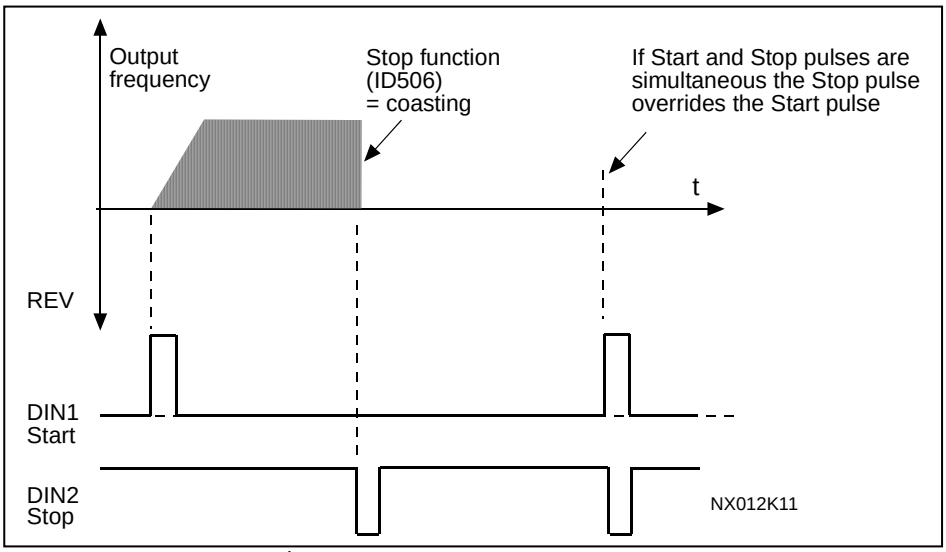

Figure 19. Start pulse/ Stop pulse.

The selections including the text **'Rising edge required to start'** shall be used to exclude the possibility of an unintentional start when, for example, power is connected, re-connected after a power failure, after a fault reset, after the drive is stopped by Run Enable (Run Enable = False) or when the control place is changed. The Start/Stop contact must be opened before the motor can be started.

4 DIN1: closed contact = start forward
DIN2: closed contact = reference increases (motor potentiometer reference; this parameter is automatically set to 4 if par. ID117 is set to 3 or 4).

5 DIN1: closed contact = start forward **(Rising edge required to start)**
DIN2: closed contact = start reverse **(Rising edge required to start)**

6 DIN1: closed contact = start **(Rising edge required to start)**
open contact = stop
DIN2: closed contact = reverse
open contact = forward

7 DIN1: closed contact = start **(Rising edge required to start)**
open contact = stop
DIN2: closed contact = start enabled
open contact = start disabled and drive stopped if running

303 *Reference scaling, minimum value*
304 *Reference scaling, maximum value*

Setting value limits: 0 ≤ par. ID303 ≤ par. ID304 ≤ par. ID102. If parameter ID303 = 0 scaling is set off. The minimum and maximum frequencies are used for scaling.

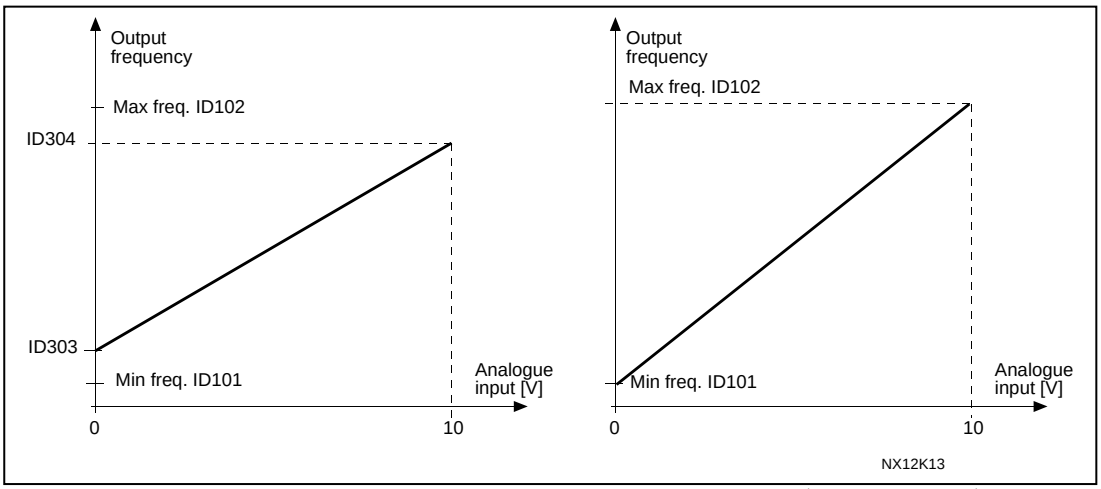

Figure 20. ***Left****: Reference scaling;* ***Right****: No scaling used (par. ID303 = 0).*

307 *Analogue output function*

This parameter selects the desired function for the analogue output signal.

.

308 *Analogue output filter time*

Defines the filtering time of the analogue output signal.
Setting this parameter value **0** will deactivate filtering.

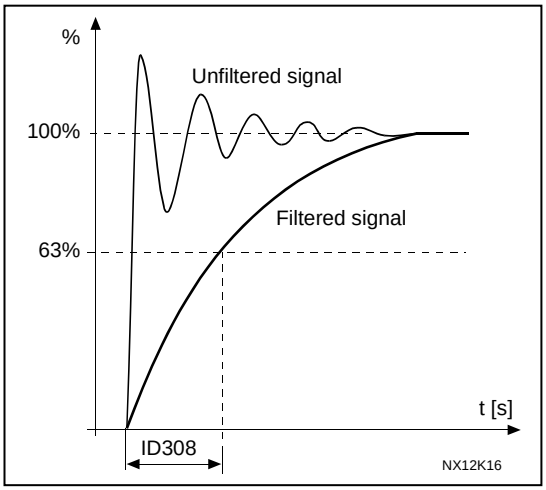

Figure 21. Analogue output filtering

309 *Analogue output inversion)*

Inverts the analogue output signal:

Maximum output signal = Minimum set value
Minimum output signal = Maximum set value

See parameter ID311 below.

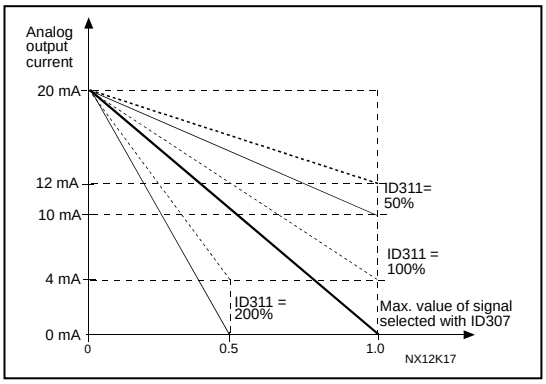

Figure 22. Analogue output invert

310 *Analogue output minimum)*

Defines the signal minimum to either 0 mA or 4 mA (living zero). Note the difference in analogue output scaling in parameter ID311 (Figure 8-15).

0 Set minimum value to 0 mA
1 Set minimum value to 4 mA

311 *Analogue output scale*

Scaling factor for analogue output.

Signal	Max. value of the signal
Output frequency	Max frequency (par.ID102)
Freq. Reference	Max frequency (par.ID102)
Motor speed	Motor nom. speed $1xn_{mMotor}$
Output current	Motor nom. current $1xI_{nMotor}$
Motor torque	Motor nom. torque $1xT_{nMotor}$
Motor power	Motor nom. power $1xP_{nMotor}$
Motor voltage	100% x U_{nmotor}
DC-link voltage	1000 V
PI-ref. value	100% x ref. value max.
PI act. value 1	100% x actual value max.
PI act. value 2	100% x actual value max.
PI error value	100% x error value max.
PI output	100% x output max.

Table 41. Analogue output scaling

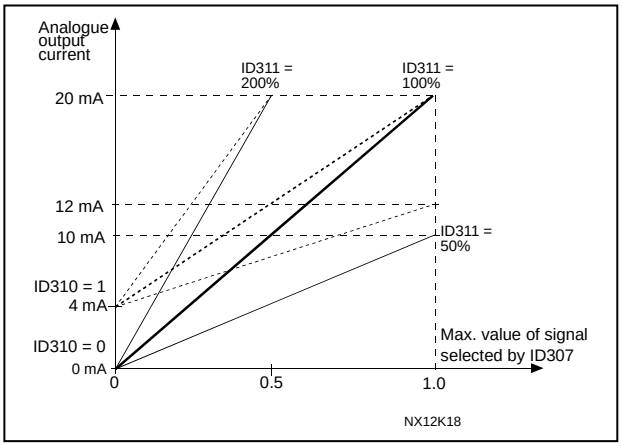

Figure 23. Analogue output scaling

312 *Digital output function*

Setting value	Signal content
0 = Not used	Out of operation
	Digital output DO1 sinks the current and programmable relay (RO1, RO2) is activated when:
1 = Ready	The frequency converter is ready to operate
2 = Run	The frequency converter operates (motor is running)
3 = Fault	A fault trip has occurred
4 = Fault inverted	A fault trip not occurred
5 = Vacon overheat warning	The heat-sink temperature exceeds +70°C
6 = External fault or warning	Fault or warning depending on par. ID701
7 = Reference fault or warning	Fault or warning depending on par. ID700 - if analogue reference is 4—20 mA and signal is <4mA
8 = Warning	Always if a warning exists
9 = Reversed	The reverse command has been selected
10 = Preset speed 1 (Applications 2) 10 = Jogging speed (Applications 3456)	The preset speed has been selected with digital input The jogging speed has been selected with digital input
11 = At speed	The output frequency has reached the set reference
12 = Motor regulator activated	Overvoltage or overcurrent regulator was activated
13 = Output frequency limit supervision	The output frequency goes outside the set supervision low limit/high limit (see parameter ID's 315 and 316 below)

14 = Control from I/O terminals (Appl. 2) 14 = Output freq.limit 2 supervision (Applications 3456)	I/O control mode selected (in menu M3) The output frequency goes outside the set supervision low limit/high limit (see parameter ID's 346 and 347 below)
15 = Thermistor fault or warning (Appl.2) 15 = Torque limit supervision (Appl.3456)	The thermistor input of option board indicates overtemperature. Fault or warning depending on par ID732. The motor torque goes beyond the set supervision low limit/high limit (par. ID348 and ID349).
16 = Fieldbus input data (Application 2) 16 = Reference limit supervision	Fieldbus input data (FBFixedControlWord) to DO/RO. Active reference goes beyond the set supervision low limit/high limit (par. ID350 and ID351)
17 = External brake control (Appl. 3456)	External brake ON/OFF control with programmable delay (par. ID352 and ID353)
18 = Control from I/O terminals (Appl. 3456)	External control mode (Menu **M3**; ID125)
19 = Frequency converter temperature limit supervision (Appl. 3456)	Frequency converter heatsink temperature goes beyond the set supervision limits (par. ID354 and ID355).
20 = Unrequested rotation direction (Appl. 345) 20 = Reference inverted (Appl. 6)	Rotation direction is different from the requested one.
21 = External brake control inverted (Appl. 3456)	External brake ON/OFF control (par. ID352 and ID353); Output active when brake control is OFF
22 = Thermistor fault or warning (Appl.3456)	The thermistor input of option board indicates overtemperature. Fault or warning depending on parameter ID732.
23 = Fieldbus input data (Application 5) 23 = On/Off control (Application 6)	Fieldbus input data (FBFixedControlWord) to DO/RO. Selects the analogue input to be monitored. See par. ID356, ID357, ID358 and ID463.
24 = Fieldbus input data 1 (Application 6)	Fieldbus data (FBFixedControlWord) to DO/RO
25 = Fieldbus input data 2 (Application 6)	Fieldbus data (FBFixedControlWord) to DO/RO
26 = Fieldbus input data 3 (Application 6)	Fieldbus data (FBFixedControlWord) to DO/RO

Table 42. Output signals via DO1 and output relays RO1 and RO2.

315 Output frequency limit supervision function

0 No supervision
1 Low limit supervision
2 High limit supervision
3 Brake-on control (see chapter 1 on page 98)

If the output frequency goes under/over the set limit (ID316) this function generates a warning message via the digital output DO1 or via the relay output RO1 or RO2 depending on the settings of parameters ID312...ID314.

316 Output frequency limit supervision value)

Selects the frequency value supervised by parameter ID315. See Figure 24.

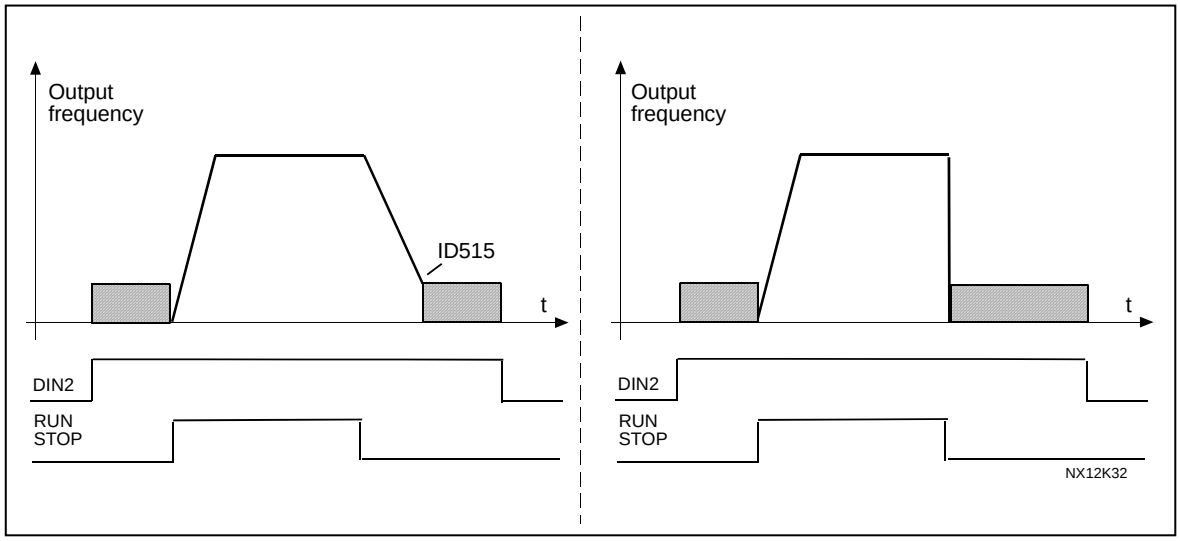

Figure 24. Output frequency supervision

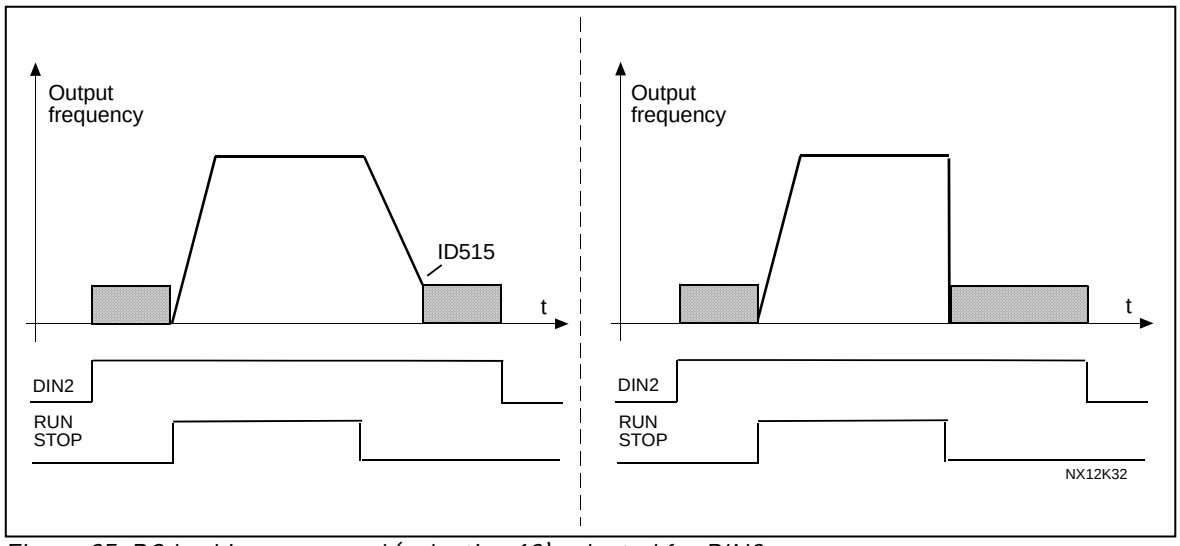

Figure 25. DC braking command (selection 12) selected for DIN2.
Left: Stop mode = Ramp; Right: Stop mode = Coasting

320 AI1 signal range

Selection	Range
0	0...100%
1	20...100%
2	Customised

Table 43. Selections for parameter ID320

For selection 'Customised', see parameters ID321 and ID322.

321 AI1 custom setting minimum
322 AI1 custom setting maximum

These parameters set the analogue input signal for any input signal span within 0—100%.

324 AI1 signal filter time

When this parameter is given a value greater than 0 the function that filters out disturbances from the incoming analogue signal is activated.

Long filtering time makes the regulation response slower. See Figure 27.

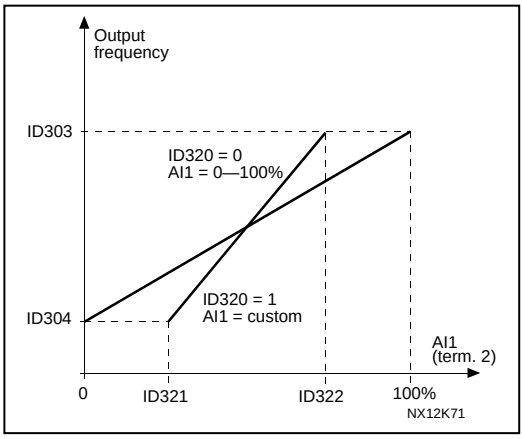

Figure 26. AI1 no signal inversion

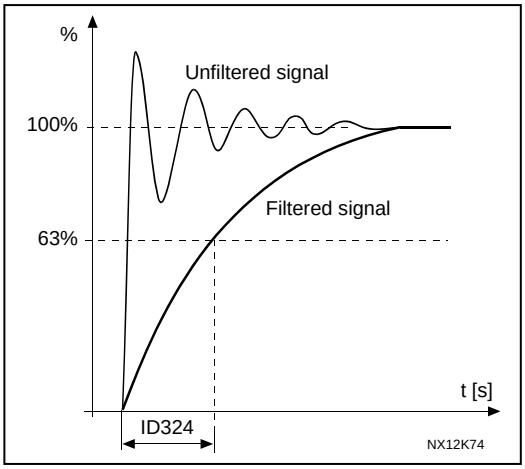

Figure 27. AI1 signal filtering

325 *Analogue input AI2 signal range*

Selection	Range
0	0...20mA
1	4...20mA
2	Customised

Table 44. Selections for parameter ID325

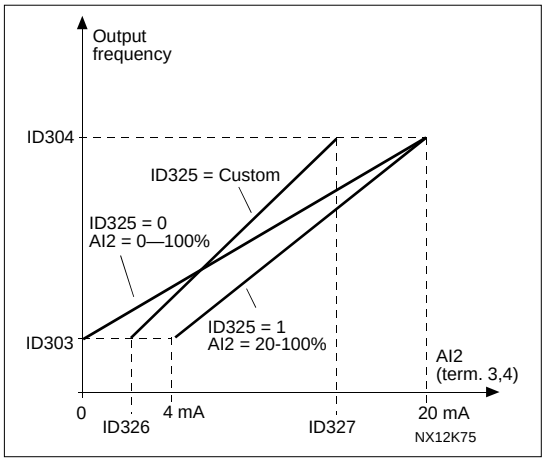

Figure 28. Analogue input AI2 scaling.

326 *Analogue input AI2 custom setting min.*
327 *Analogue input AI2 custom setting max.*

These parameters set AI2 for any input signal span within 0...100%.

329 *Analogue input AI2 (I_{in}) filter time*

See ID324.

331 *Motor potentiometer ramp time)*

Defines the speed of change of the motor potentiometer value.

346 *Output freq. limit 2 supervision function*

0 No supervision
1 Low limit supervision
2 High limit supervision
3 Brake-on control (See chapter 1 on page 98)
4 Brake-on/off control (See chapter 1 on page 98)

If the output frequency goes under/over the set limit (ID347) this function generates a warning message via the digital output DO1 and via the relay output RO1 or RO2 depending on to which output the supervision signals (par. ID447 and ID448) are connected.

347 *Output frequency limit 2 supervision value*

Selects the frequency value supervised by parameter ID346. See Figure 24.

348 *Torque limit, supervision function*

0 = No supervision
1 = Low limit supervision
2 = High limit supervision
3 = Brake-off control (see chapter 1 on page 98)

If the calculated torque value falls below or exceeds the set limit (ID349) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on to which output the supervision signal (par. ID451) is connected.

349 *Torque limit, supervision value)*

Set here the torque value to be supervised by parameter ID348.

350 *Reference limit, supervision function*

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the reference value falls below or exceeds the set limit (ID351), this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on to which output the supervision signal (par. ID449) is connected

The supervised reference is the selected active reference.

351 *Reference limit, supervision value*

The frequency value to be supervised with the parameter ID350.

352 *External brake-off delay*
353 *External brake-on delay)*

The function of the external brake can be timed to the start and stop control signals with these parameters. See Figure 29 and chapter 1 on page 98.

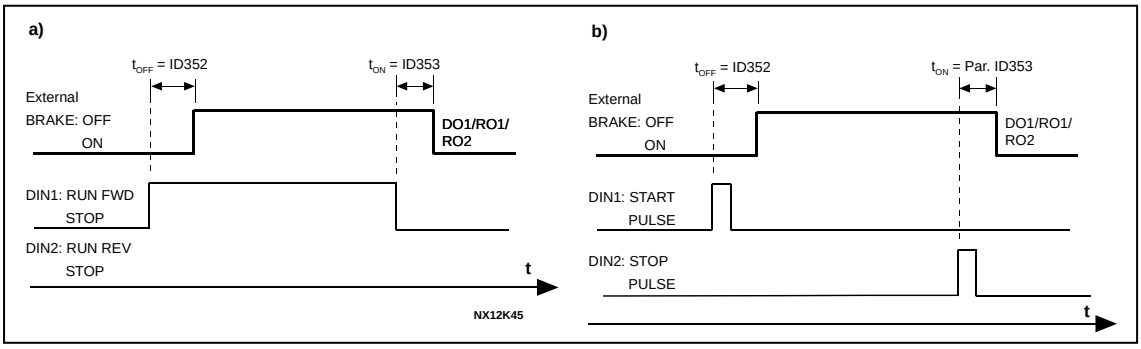

Figure 29. External brake control:
a) Start/Stop logic selection, ID300 = 0, 1 or 2
b) Start/Stop logic selection, ID300= 3

354 *Frequency converter temperature limit supervision*

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the temperature of the frequency converter unit falls below or exceeds the set limit (ID355), this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on to which output the supervision signal (par. ID450) is connected.

355 *Frequency converter temperature limit value*

This temperature value is supervised by parameter ID354.

367 *Motor potentiometer memory reset (Frequency reference))*

0 No reset
1 Memory reset in stop and powerdown
2 Memory reset in powerdown

377 *AI1 signal selection*

Connect the AI1 signal to the analogue input of your choice with this parameter. For more information about the TTF programming method, see chapter 2

388 *AI2 signal selection*

Connect the AI2 signal to the analogue input of your choice with this parameter. For more information about the TTF programming method, see chapter 2

393 *AI2 reference scaling, minimum value*
394 *AI2 reference scaling, maximum value*

See ID's 303 and 304.

399 *Scaling of current limit*

0 = Not used
1 = AI1
2 = AI2
3 = AI3
4 = AI4
5 = Fieldbus (FBProcessDataIN2)

This signal will adjust the maximum motor current between 0 and max. limit set with parameter ID107.

403 *Start signal 1*

Signal selection 1 for the start/stop logic.
Default programming A.1.

404 *Start signal 2*

Signal selection 2 for the start/stop logic.
Default programming A.2.

405 *External fault (close)*

Contact closed: Fault is displayed and motor stopped.

406 *External fault (open)*

Contact open: Fault is displayed and motor stopped.

407 *Run enable*

Contact open: Start of motor disabled
Contact closed: Start of motor enabled

409 *Control from I/O terminal*

Contact closed: Force control place to I/O terminal

410 *Control from keypad*

Contact closed: Force control place to keypad

411 *Control from fieldbus*

Contact closed: Force control place to fieldbus

NOTE: When the control place is forced to change the values of Start/Stop, Direction and Reference valid in the respective control place are used.
The value of parameter ID125 (Keypad Control Place) does not change.
When the input opens the control place is selected according to keypad control parameter ID125.

412 *Reverse*

Contact open: Direction forward
Contact closed: Direction reverse

414 *Fault reset*

Contact closed: All faults are reset.

416 *DC-braking*

Contact closed: In STOP mode, the DC braking operates until the contact is opened.

417 *Motor potentiometer DOWN*

Contact closed: Motor potentiometer reference DECREASES until the contact is opened.

418 *Motor potentiometer UP*

Contact closed: Motor potentiometer reference INCREASES until the contact is opened.

419 *Preset speed 1*
420 *Preset speed 2*

Parameter values are automatically limited between the minimum and maximum frequencies (parameters ID101 and ID102).

422 *AI1/AI2 selection*

With this parameter you can select either AI1 or AI2 signal for frequency reference.

432 *Ready*

The frequency converter is ready to operate.

433 *Run*

The frequency converter operates (the motor is running).

434 *Fault*

A fault trip has occurred.
Default programming: A.1.

435 *Inverted fault*

No fault trip has occurred.

436 *Warning*

General warning signal.

437 *External fault or warning*

Fault or warning depending on par. ID701.

439 *Overtemperature warning*

The heatsink temperature exceeds +70°C.

440 *Reverse*

The Reverse command has been selected.

441 *Unrequested direction*

Motor rotation direction is different from the requested one.

442 *At speed*

The output frequency has reached the set reference.

444 *External control place*

Control from I/O terminal selected (Menu M3; par. ID125).

445 *External brake control*

External brake ON/OFF control with programmable delay.

446 *External brake control, inverted*

External brake ON/OFF control; Output active when brake control is OFF.

447 *Output frequency limit 1 supervision*

The output frequency goes outside the set supervision low limit/high limit (see parameters ID315 and ID316)

448 *Output frequency limit 2 supervision*

The output frequency goes outside the set supervision low limit/high limit (see parameters ID346 and ID347)

449 *Reference limit supervision*

Active reference goes beyond the set supervision low limit/high limit (see parameters ID350 and ID351).

450 *Temperature limit supervision*

Frequency converter heatsink temperature goes beyond the set supervision limits (see parameters ID354 and ID355).

451 *Torque limit supervision*

The motor torque goes beyond the set supervision limits (see parameters ID348 and ID349).

452 *Motor thermal protection*

Motor thermistor initiates a overtemperature signal which can be led to a digital output.

NOTE: This parameter will not work unless you have Vacon NXOPTA3 or NXOPTB2 (thermistor relay board) connected.

454 *Motor regulator activation*

Overvoltage or overcurrent regulator has been activated.

455 *Fieldbus input data 1 (FBFixedControlWord, bit 3)*
456 *Fieldbus input data 2 (FBFixedControlWord, bit 4)*
457 *Fieldbus input data 3 (FBFixedControlWord, bit 5)*

The data from the fieldbus (FBFixedControlWord) can be led to frequency converter digital outputs.

464 *Analogue output 1 signal selection*

Connect the AO1 signal to the analogue output of your choice with this parameter. For more information about the TTF programming method, see chapter 0.

485 *Torque limit*

See par. ID399 for the selections.

486 *Digital output 1 signal selection*

Connect the delayed DO1 signal to the digital output of your choice with this parameter. For more information about the TTF programming method, see chapter 2.

487 *Digital output 1 on-delay*
488 *Digital output 1 off-delay*

With these parameters you can set on- and off-delays to digital outputs.

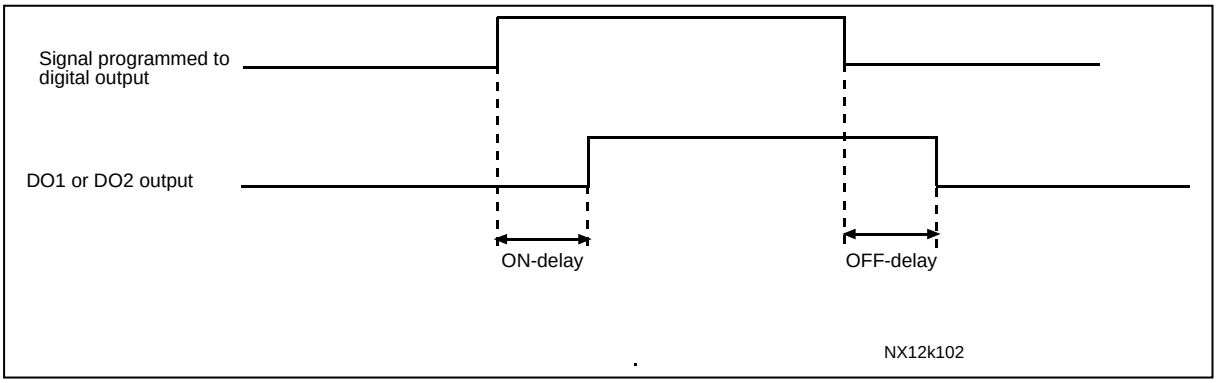

Figure 30. Digital outputs 1 and 2, on- and off-delays

489 *Digital output 2 signal selection*

See ID486.

490 *Digital output 2 function*

See ID312.

491 *Digital output 2 on-delay*

See ID487.

492 *Digital output 2 off-delay*

See ID488.

493 *Adjust input*

With this parameter you can select the signal, according to which the frequency reference to the motor is fine adjusted.

0 Not used
1 Analogue input 1
2 Analogue input 2
3 Analogue input 3
4 Analogue input 4
5 Signal from fieldbus (FBProcessDataIN)

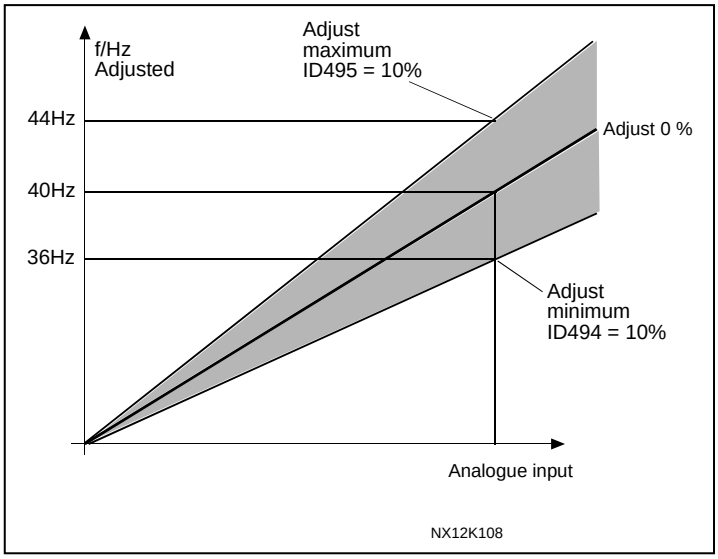

Figure 31. An example of adjust input

494 *Adjust minimum*
495 *Adjust maximum*

These parameters define the minimum and maximum of adjusted signals. See Figure 31.

496 *Parameter Set 1/Set 2 selection*

With this parameter you can select between Parameter Set 1 and Set 2. The input for this function can be selected from any slot. The procedure of selecting between the sets is explained in Vacon NX User's Manual, Chapter 7.3.6.3.

Digital input = FALSE:
- The active set is saved to set 2
- Set 1 is loaded as the active set

Digital input = TRUE:
- The active set is saved to set 1
- Set 2 is loaded as the active set

Note: The parameter values can be changed in the active set only.

504 *Brake chopper*

0 = No brake chopper used
1 = Brake chopper in use and tested when running. Can be tested also in READY state
2 = External brake chopper (no testing)
3 = Used and tested in READY state and when running
4 = Used when running (no testing)

When the frequency converter is decelerating the motor, the inertia of the motor and the load are fed into an external brake resistor. This enables the frequency converter to decelerate the load with a torque equal to that of acceleration (provided that the correct brake resistor has been selected). See separate Brake resistor installation manual.

505 *Start function*

Ramp:
0 The frequency converter starts from 0 Hz and accelerates to the set reference frequency within the set acceleration time. (Load inertia or starting friction may cause prolonged acceleration times).

Flying start:
1 The frequency converter is able to start into a running motor by applying a small torque to motor and searching for the frequency corresponding to the speed the motor is running at. Searching starts from the maximum frequency towards the actual frequency until the correct value is detected. Thereafter, the output frequency will be increased/decreased to the set reference value according to the set acceleration/deceleration parameters.

Use this mode if the motor is coasting when the start command is given. With the flying start it is possible to ride through short mains voltage interruptions.

506 *Stop function*

Coasting:

0 The motor coasts to a halt without any control from the frequency converter, after the Stop command.

Ramp:

1 After the Stop command, the speed of the motor is decelerated according to the set deceleration parameters.
If the regenerated energy is high it may be necessary to use an external braking resistor for faster deceleration.

Normal stop: Ramp/ Run Enable stop: coasting

2 After the Stop command, the speed of the motor is decelerated according to the set deceleration parameters. However, when Run Enable is selected, the motor coasts to a halt without any control from the frequency converter.

Normal stop: Coasting/ Run Enable stop: ramping

3 The motor coasts to a halt without any control from the frequency converter. However, when Run Enable signal is selected, the speed of the motor is decelerated according to the set deceleration parameters. If the regenerated energy is high it may be necessary to use an external braking resistor for faster deceleration.

507 *DC-braking current*

Defines the current injected into the motor during DC-braking.

508 *DC-braking time at stop*

Determines if braking is ON or OFF and the braking time of the DC-brake when the motor is stopping. The function of the DC-brake depends on the stop function, parameter ID506.

0 DC-brake is not used
>0 DC-brake is in use and its function depends on the Stop function, (param. ID506). The DC-braking time is determined with this parameter.

Par. ID506 = 0; Stop function = Coasting:

After the stop command, the motor coasts to a stop without control of the frequency converter.

With DC-injection, the motor can be electrically stopped in the shortest possible time, without using an optional external braking resistor.

The braking time is scaled according to the frequency when the DC-braking starts. If the frequency is ≥ the nominal frequency of the motor, the set value of parameter ID508 determines the braking time. When the frequency is ≤10% of the nominal, the braking time is 10% of the set value of parameter ID508.

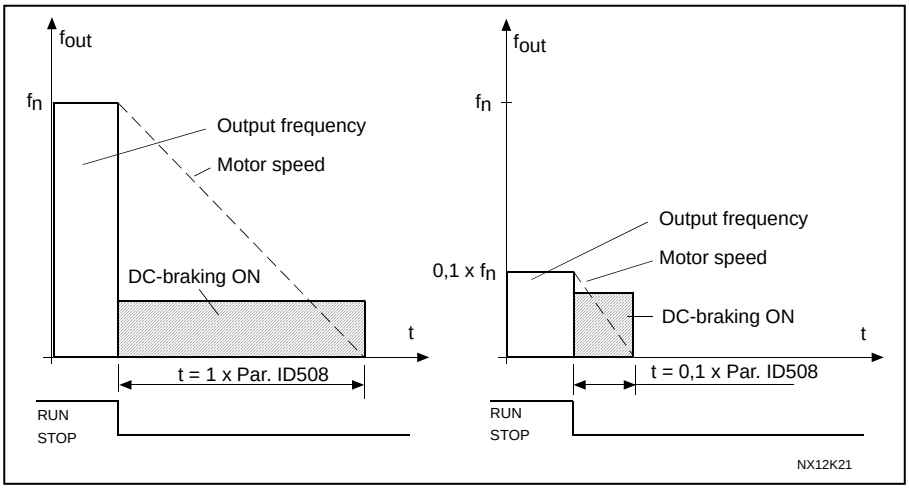

Figure 32. DC-braking time when Stop mode = Coasting.

Par. ID506 = 1; Stop function = Ramp:

After the Stop command, the speed of the motor is reduced according to the set deceleration parameters, as fast as possible, to the speed defined with parameter ID515, where the DC-braking starts.

The braking time is defined with parameter ID508. If high inertia exists, it is recommended to use an external braking resistor for faster deceleration. See Figure 33.

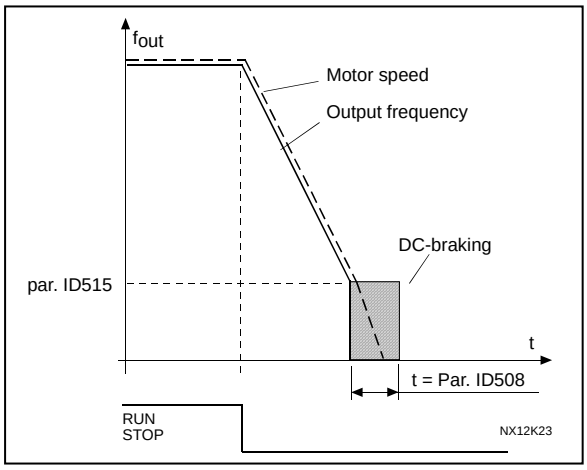

Figure 33. DC-braking time when Stop mode = Ramp

515 DC-braking frequency at stop

The output frequency at which the DC-braking is applied. See Figure 33.

516 DC-braking time at start

DC-brake is activated when the start command is given. This parameter defines the time before the brake is released. After the brake is released, the output frequency increases according to the set start function by parameter ID505.

519 Flux braking current

Defines the flux braking current value. This value can be set between 0.1*I_{nMotor} and the Current limit.

520 *Flux brake*

The flux braking can be set ON or OFF.

0 = Flux braking OFF
1 = Flux braking ON

600 *Motor control mode*

0	Frequency control:	The I/O terminal and keypad references are frequency references and the frequency converter controls the output frequency (output frequency resolution = 0.01 Hz)
1	Speed control:	The I/O terminal and keypad references are speed references and the frequency converter controls the motor speed compensating the motor slip (accuracy ± 0,5%).
2	Torque control	In torque control mode, the references are used to control the motor torque.
3	Speed ctrl (closed loop)	The I/O terminal and keypad references are speed references and the frequency converter controls the motor speed very accurately comparing the actual speed received from the tachometer to the speed reference (accuracy ±0.01%).
4	Torque ctrl (closed loop)	The I/O terminal and keypad references are torque references and the frequency converter controls the motor torque.
5	Frequency control (advanced open loop)	Frequency control with better performance at lower speeds.
6	Speed control (advanced open loop)	Speed control with better performance at lower speeds.

601 *Switching frequency*

Motor noise can be minimised using a high switching frequency. Increasing the switching frequency reduces the capacity of the frequency converter unit.
The range of this parameter depends on the size of the frequency converter:

Type	Min. [kHz]	Max. [kHz]	Default
0003—0061 NX5	1.0	16,0	10.0
0072—0300 NX5	1.0	10.0	3.6

Table 45. Size-dependent switching frequencies

602 *Field weakening point*

The field weakening point is the output frequency at which the output voltage reaches the set (ID603) maximum value.

603 *Voltage at field weakening point*

Above the frequency at the field weakening point, the output voltage remains at the set maximum value. Below the frequency at the field weakening point, the output voltage depends on the setting of the U/f curve parameters. See parameters ID109, ID108, ID604 and ID605.

When the parameters ID110 and ID111 (nominal voltage and nominal frequency of the motor) are set, the parameters ID602 and ID603 are automatically given the corresponding values. If you need different values for the field weakening point and the maximum output voltage, change these parameters **after** setting the parameters ID110 and ID111.

604 *U/f curve, middle point frequency*

If the programmable U/f curve has been selected with parameter ID108 this parameter defines the middle point frequency of the curve. See Figure 15.

605 *U/f curve, middle point voltage*

If the programmable U/f curve has been selected with the parameter ID108 this parameter defines the middle point voltage of the curve. See Figure 15.

606 *Output voltage at zero frequency*

If the programmable U/f curve has been selected with the parameter ID108 this parameter defines the zero frequency voltage of the curve. See Figure 15.

607 *Overvoltage controller*

These parameters allow the under-/overvoltage controllers to be switched out of operation. This may be useful, for example, if the mains supply voltage varies more than –15% to +10% and the application will not tolerate this over-/undervoltage. In this case, the regulator controls the output frequency taking the supply fluctuations into account.

0 Controller switched off
1 Controller switched on (no ramping) = Minor adjustments of OP frequency are made
2 Controller switched on (with ramping) = Controller adjusts OP freq. up to max.freq.

608 *Undervoltage controller*

See par. ID607.

Note: Over-/undervoltage trips may occur when controllers are switched out of operation.

0 Controller switched off
1 Controller switched on

609 *Torque limit*

With this parameter you can set the torque limit control between 0.0 – 400.0 %.

612 *CL: Magnetizing current*

Set here the motor magnetizing current (no-load current). See chapter 9.1.

613 *CL: Speed control P gain*

Sets the gain for the speed controller in % per Hz. See chapter 9.1.

614 *CL: Speed control I time*

Sets the integral time constant for the speed controller. Increasing the I-time increases stability but lengthens the speed response time. See chapter 9.1.

615 *CL: Zero speed time at start*

After giving the start command the drive will remain at zero speed for the time defined by this parameter. The ramp will be released to follow the set frequency/speed reference after this time has elapsed from the instant where the command is given. See chapter 9.1. Motor should be magnetized during this time.

616 *CL: Zero speed time at stop*

The drive will remain at zero speed with controllers active for the time defined by this parameter after reaching the zero speed when a stop command is given. This parameter has no effect if the selected stop function (ID506) is *Coasting*. See chapter 9.1.

617 *CL: Current control P gain*

Sets the gain for the current controller. This controller is active only in closed loop and advanced open loop modes. The controller generates the voltage vector reference to the modulator. See chapter 9.1.

618 *CL: Encoder filter time)*

Sets the filter time constant for speed measurement.
The parameter can be used to eliminate encoder signal noise. Too high a filter time reduces speed control stability. See chapter 9.1.

619 *CL: Slip adjust*

The motor name plate speed is used to calculate the nominal slip. This value is used to adjust the voltage of motor when loaded. The name plate speed is sometimes a little inaccurate and this parameter can therefore be used to trim the slip. Reducing the slip adjust value increases the motor voltage when the motor is loaded. See chapter 9.1.

620 *CL: Load drooping*

The drooping function enables speed drop as a function of load. This parameter sets that amount corresponding to the nominal torque of the motor. See chapter 9.1.

621 *CL: Startup torque)*

Choose here the startup torque.
Torque Memory is used in crane applications. Startup Torque FWD/REV can be used in other applications to help the speed controller. See chapter 9.1.
0 = Not Used
1 = TorqMemory
2 = Torque Ref
3 = Torq.Fwd/Rev

631 *Identification*

Identification Run is a part of tuning the motor and the drive specific parameters. It is a tool for commissioning and service of the drive with the aim to find as good parameter values as possible for most drives. The automatic motor identification calculates or measures the motor parameters that are needed for optimum motor and speed control.

0 = No action

No identification requested.

1 = Identification without motor run

The drive is run without speed to identify the motor parameters. The motor is supplied with current and voltage but with zero frequency.

2 = Identification with motor run

The drive is run with speed to identify the motor parameters.
Note: It is recommended to do the this identification test with no load on the motor for best results.

The basic motor name plate data has to be set correctly before performing the identification run:

ID110 *Nominal voltage of the motor (par. 2.1.5)*
ID111 *Nominal frequency of the motor (par. 2.1.6)*
ID112 *Nominal speed of the motor (par. 2.1.7)*
ID113 *Nominal current of the motor (par. 2.1.8)*
ID120 *Motor cos phi (par. 2.1.9)*

When in closed loop and with an encoder installed, also the parameter for pulses / revolutions (in Menu M7) has to be set.
The automatic identification is activated by setting this parameter to the appropriate value followed by a start command in the requested direction. The start command to the drive has to be given within 20 s. If no start command is given within 20 s the identification run is cancelled and the parameter will be reset to its default setting. The identification run can be stopped any time with normal stop command and the parameter is reset to its default setting. In case identification run detects fault or other problems, the identification run is completed if possible. After the identification is finished, the application checks the status of the identification and generates fault/ warning if any.
During Identification Run, the brake control is disabled (see chapter 1).

3 = Encoder identification run

For PMS motor drive will make angle identification run when absolute encoder is in use.

4 = No Action

5 = Identification failed

649 *PMS motor shaft position* *6* *(2.6.28.4)*

Identified zero shaft position when using absolute encoder for PMS motor.

650 *Motor type*

Selection of motor type, drive must be in stop state to edit.

0 Asynchronous induction motor
1 Permanent magnet synchronous motor ("AC brushless") control

651 *Flux current Kp*

Defines the gain for the flux current controller when a PMS motor is used.

652 *Flux current Ti*

Defines the integration time for the flux current controller when a PMS motor is used.

654 *Enable Rs identification*

With this parameter its possible to disable Rs identification during DC brake start.

655 *Modulator index limit*

Defines used voltage ration in field weakening area with PMS motors

662 *Rs voltage drop*

Measured Voltage drop at stator resistanse between two phases with nom current of motor.

701 *Response to external fault*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to ID506
3 = Fault, stop mode after fault always by coasting

A warning or a fault action and message is generated from the external fault signal in the programmable digital inputs DIN3. The information can also be programmed into digital output DO1 and into relay outputs RO1 and RO2.

702 *Output phase supervision)*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to ID506
3 = Fault, stop mode after fault always by coasting

Output phase supervision of the motor ensures that the motor phases have an approximately equal current.

703 *Earth fault protection*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to ID506
3 = Fault, stop mode after fault always by coasting

Earth fault protection ensures that the sum of the motor phase currents is zero. The overcurrent protection is always working and protects the frequency converter from earth faults with high currents.

704 *Motor thermal protection*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to ID506
3 = Fault, stop mode after fault always by coasting

If tripping is selected the drive will stop and activate the fault stage.
Deactivating the protection, i.e. setting parameter to 0, will reset the thermal stage of the motor to 0%. See chapter 9.3.

705 *Motor thermal protection: Motor ambient temp. factor*

The factor can be set between -100.0%—100.0%. See chapter 9.3.

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706 *Motor thermal protection: Motor cooling factor at zero speed*

The current can be set between 0—150.0% x I_{nMotor}. This parameter sets the value for thermal current at zero frequency. See Figure 34.

The default value is set assuming that there is no external fan cooling the motor. If an external fan is used this parameter can be set to 90% (or even higher).

Note: The value is set as a percentage of the motor name plate data, par. ID113 (Nominal current of motor), not the drive's nominal output current. The motor's nominal current is the current that the motor can withstand in direct on-line use without being overheated.

If you change the parameter Nominal current of motor, this parameter is automatically restored to the default value.
Setting this parameter does not affect the maximum output current of the drive which is determined by parameter ID107 alone. See chapter 9.3.

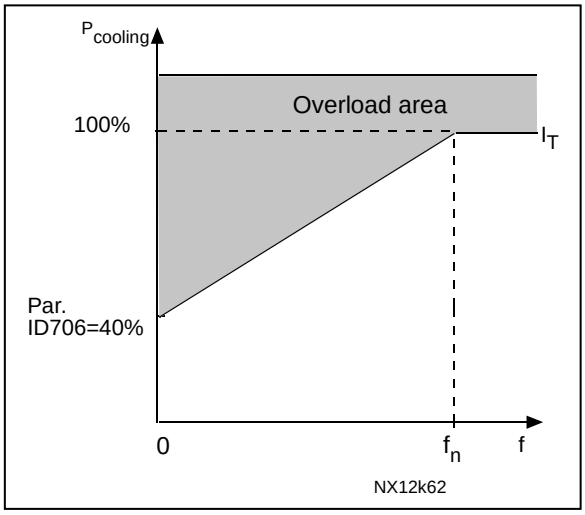

Figure 34. Motor thermal current I_T curve

707 *Motor thermal protection: Time constant*

This time can be set between 1 and 200 minutes.

This is the thermal time constant of the motor. The bigger the motor, the bigger the time constant. The time constant is the time within which the calculated thermal stage has reached 63% of its final value.

The motor thermal time is specific to the motor design and it varies between different motor manufacturers.

If the motor's t6–time (t6 is the time in seconds the motor can safely operate at six times the rated current) is known (given by the motor manufacturer) the time constant parameter can be set basing on it. As a rule of thumb, the motor thermal time constant in minutes equals to 2xt6. If the drive is in stop stage the time constant is internally increased to three times the set parameter value. The cooling in the stop stage is based on convection and the time constant is increased. See also Figure 35.

708 *Motor thermal protection: Motor duty cycle*

Defines how much of the nominal motor load is applied.
The value can be set to 0%...100%. See chapter 9.3.

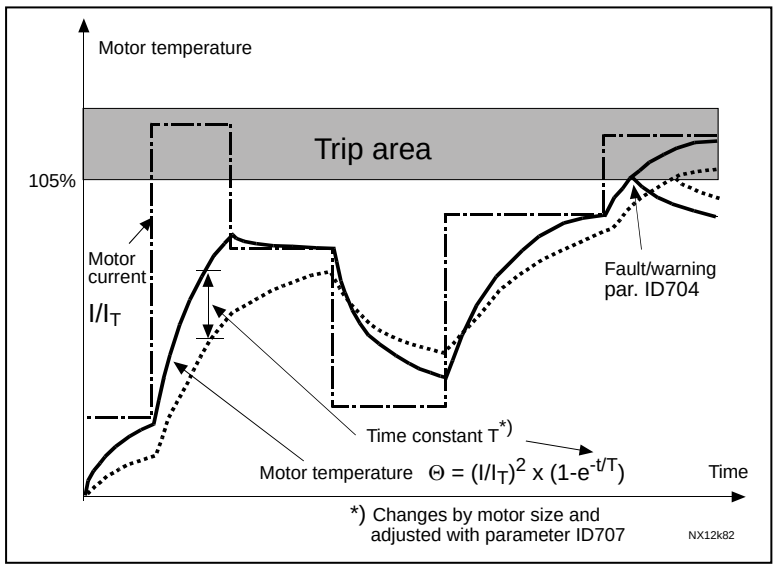

Figure 35. Motor temperature calculation

717 *Automatic restart: Wait time*

Defines the time before the frequency converter tries to automatically restart the motor after the fault has disappeared.

718 *Automatic restart: Trial time*

The Automatic restart function restarts the frequency converter when the faults selected with parameters ID720 to ID725 have disappeared and the waiting time has elapsed.

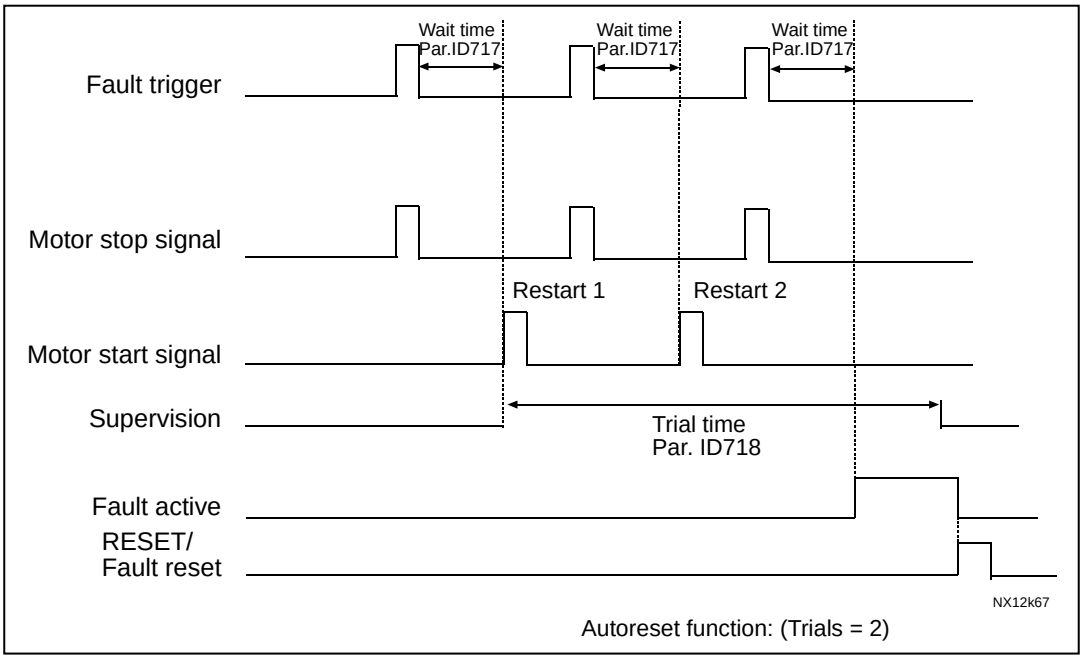

Figure 36. Example of Automatic restart with two restarts.

Parameters ID720 to ID725 determine the maximum number of automatic restarts during the trial time set by parameter ID718. The time count starts from the first autorestart. If the number of faults occurring during the trial time exceeds the values of parameters ID720 to ID725, the fault state becomes active. Otherwise the fault is cleared after the trial time has elapsed and the next fault starts the trial time count again.

If a single fault remains during the trial time, a fault state is true.

719 *Automatic restart: Start function*

The Start function for Automatic restart is selected with this parameter. The parameter defines the start mode:

0 = Start with ramp
1 = Flying start
2 = Start according to ID505

720 *Automatic restart: Number of tries after undervoltage fault trip*

This parameter determines how many automatic restarts can be made during the trial time set by parameter ID718 after an undervoltage trip.

0	=	No automatic restart after undervoltage fault trip
>0	=	Number of automatic restarts after undervoltage fault. The fault is reset and the drive is started automatically after the DC-link voltage has returned to the normal level.

721 *Automatic restart: Number of tries after overvoltage trip*

This parameter determines how many automatic restarts can be made during the trial time set by ID718 after an overvoltage trip.

0	=	No automatic restart after overvoltage fault trip
>0	=	Number of automatic restarts after overvoltage fault. The fault is reset and the drive is started automatically after the DC-link voltage has returned to the normal level.

722 *Automatic restart: Number of tries after overcurrent trip*

(NOTE! IGBT temp Fault also included)
This parameter determines how many automatic restarts can be made during the trial time set by ID718.

0	=	No automatic restart after overcurrent fault trip
>0	=	Number of automatic restarts after overcurrent trip, saturation trip and IGBT temperature faults.

725 *Automatic restart: Number of tries after external fault trip*

This parameter determines how many automatic restarts can be made during the trial time set by ID718.

0	=	No automatic restart after External fault trip
>0	=	Number of automatic restarts after External fault trip

726 *Automatic restart: Number of tries after motor temperature fault trip*

This parameter determines how many automatic restarts can be made during the trial time set by ID718.

0 = No automatic restart after Motor temperature fault trip
>0 = Number of automatic restarts after the motor temperature has returned to its normal level.

727 *Response to undervoltage fault*

1 = Warning
2 = Fault, stop mode after fault according to ID506
3 = Fault, stop mode after fault always by coasting

For the undervoltage limits see Vacon NX User's Manual, Table 4-2.

730 *Input phase supervision*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to ID506
3 = Fault, stop mode after fault always by coasting

The input phase supervision ensures that the input phases of the frequency converter have an approximately equal current.

732 *Response to thermistor fault*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to ID506
3 = Fault, stop mode after fault always by coasting

Setting the parameter to 0 will deactivate the protection.

733 *Response to fieldbus fault*

Set here the response mode for the fieldbus fault if a fieldbus board is used. For more information, see the respective Fieldbus Board Manual.

See parameter ID732.

734 *Response to slot fault*

Set here the response mode for a board slot fault due to missing or broken board.

See parameter ID732.

738 *Automatic restart: Number of tries after underload fault trip*

This parameter determines how many automatic restarts can be made during the trial time set by parameter ID718.

0 = No automatic restart after Underload fault trip
>0 = Number of automatic restarts after Underload fault trip

852 to 859 *Fieldbus data out selections 1 to 8*

Using these parameters, you can monitor any monitoring or parameter from the fieldbus.
Enter the ID number of the item you wish to monitor for the value of these parameters. See chapter 9.6.

Some typical values:

1	Output frequency	15	Digital inputs 1,2,3 statuses
2	Motor speed	16	Digital inputs 4,5,6 statuses
3	Motor current	17	Digital and relay output statuses
4	Motor torque	25	Frequency reference
5	Motor power	26	Analogue output current
6	Motor voltage	27	AI3
7	DC link voltage	28	AI4
8	Unit temperature	31	AO1 (expander board)
9	Motor temperature	32	AO2 (expander board)
13	AI1	37	Active fault 1
14	AI2		

Table 46.

1540 *Axis ready*

Position controller is ready for the next command. Signal goes low during positioning. Axis ready is not the same as In Position.

1541 *Calibration OK*

Indication that the calibration cycle is done. Position commands (except Jog) are not allowed if axis is not calibrated.

1542 *In home position*

Motor is positioned in home position.

1543 *In position*

Goes high when axis arrives to the target position.

1544 *Home Pos. or In Position*

OR function of ID1542 and ID1543. Signal is high if Position controller is in Home position or in Position.

1545 *Fault and stopped*

Output for that a fault has occurred and the drive is stopped (for mech. brake control)

1546 *Fault and stopped, inverted logic*

Same as above but inverted logic.

1822 *Speed controller f0 point*

The speed level in Hz below which the speed controller gain is equal to par. ID1824.

1823 *Speed controller f1 point*

The speed level in Hz above which the speed controller gain is equal to par. ID613. From the speed defined by par. ID1822 to speed defined by par. ID1823, the speed controller gain changes linearly from par. ID1824 to ID613 and vice versa.

1824 *Speed controller gain f0*

The relative gain of the speed controller as a percentage of par. ID613 when the speed is below the level defined by ID1822.

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8. KEYPAD CONTROL PARAMETERS

Unlike the parameters listed above, these parameters are located in the M3 menu of the control keypad. The reference parameters do not have an ID number.

114 ***Stop button activated*** *(3.4)*

If you wish to make the Stop button a "hotspot" which always stops the drive regardless of the selected control place, give this parameter the value 1.

See also parameter ID125.

125 ***Control Place*** *(3.1)*

The active control place can be changed with this parameter. For more information, see Vacon NX User's Manual, Chapter 7.3.3.1.

Pushing the *Start button* for 3 seconds selects the control keypad as the active control place and copies the Run status information (Run/Stop, direction and reference).

123 ***Keypad Direction*** *(3.3)*

0 Forward: The rotation of the motor is forward, when the keypad is the active control place.

1 Reverse: The rotation of the motor is reversed, when the keypad is the active control place.

For more information, see Vacon NX User's Manual, Chapter 7.3.3.3.

R3.2 ***Keypad Reference*** *(3.2)*

The frequency reference can be adjusted from the keypad with this parameter.

The output frequency can be copied as the keypad reference by pushing the *Stop button* for 3 seconds when you are on any of the pages of menu *M3*. For more information, see Vacon NX User's Manual, Chapter 7.3.3.2.

9. APPENDICES

In this chapter you will find additional information on special parameter groups. Such groups are:

- *Parameters of External brake control with additional limits (Chapter 1)*
- *Closed Loop parameters (Chapter 9.1)*
- *Advanced Open Loop parameters (Chapter 9.2)*
- *Parameters of Motor thermal protection (Chapter 9.3)*
- *Parameters of Stall protection (Chapter 9.4)*
- *Parameters of Underload protection (Chapter 9.5)*
- *Fieldbus control parameters (Chapter 9.6)*

1. EXTERNAL BRAKE CONTROL WITH ADDITIONAL LIMITS (ID'S 315, 316, 346 TO 349, 352, 353)

The external brake used for additional braking can be controlled through parameters ID315, ID316, ID346 to ID349 and ID352/ID353. Selecting On/Off Control for the brake, defining the frequency or torque limit(s) the brake should react to and defining the Brake-On/-Off delays will allow an effective brake control. See Figure 37.

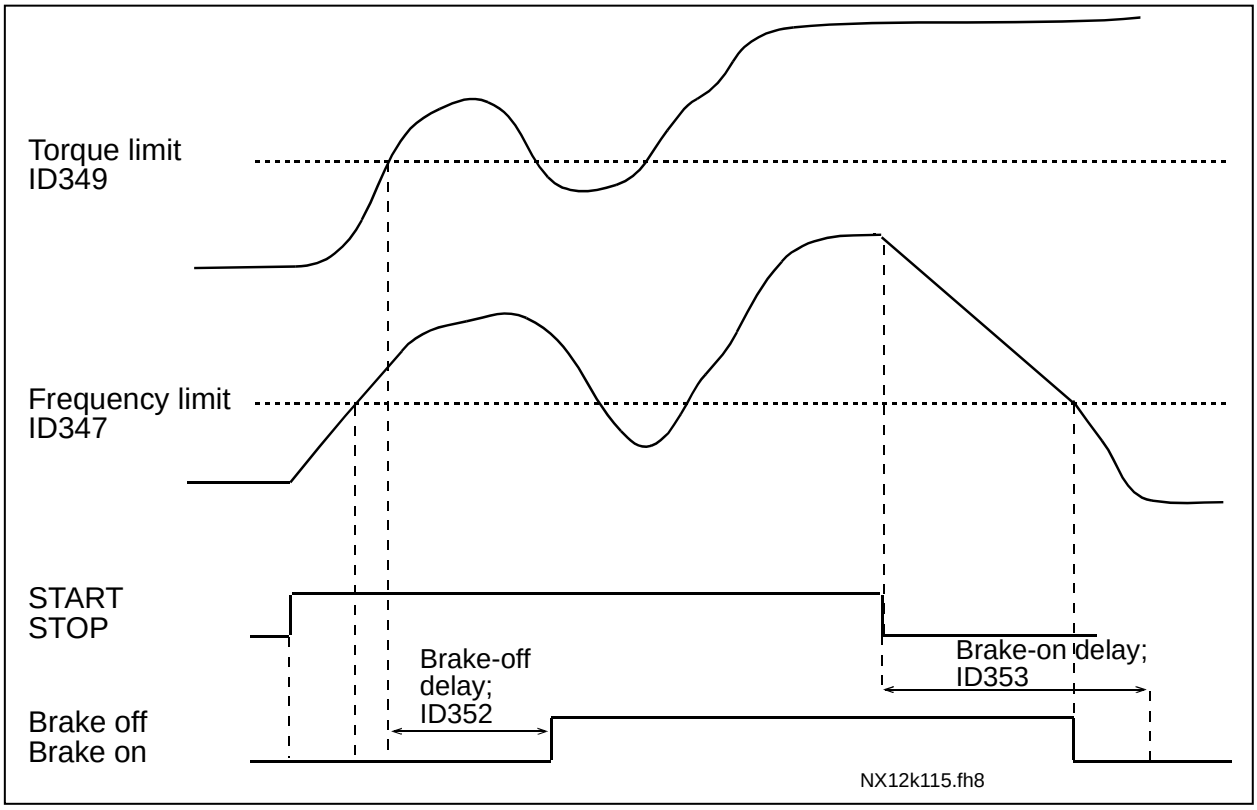

Figure 37. Brake control with additional limits

In Figure 37 above, the brake control is set to react to both the torque supervision limit (par. ID349) and frequency supervision limit (ID347). Additionally, the same frequency limit is used for both brake-off and brake-on control by giving parameter ID346 the value **4**. Use of two different frequency limits is also possible. Then parameters ID315 and ID346 must be given the value **3**.

Brake-off: In order for the brake to release, three conditions must be fulfilled: 1) the drive must be in Run state, 2) the torque must be over the set limit (if used) and 3) the output frequency must be over the set limit (if used).

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Brake-on: Stop command activates the brake delay count and the brake is closed when the output frequency falls below the set limit (ID315 or ID346). As a precaution, the brake closes when the brake-on delay expires, at the latest.
Note: A fault or Stop state will close the brake immediately without a delay.

See Figure 38.

It is strongly advisable that the brake-on delay be set longer than the ramp time in order to avoid damaging of the brake.

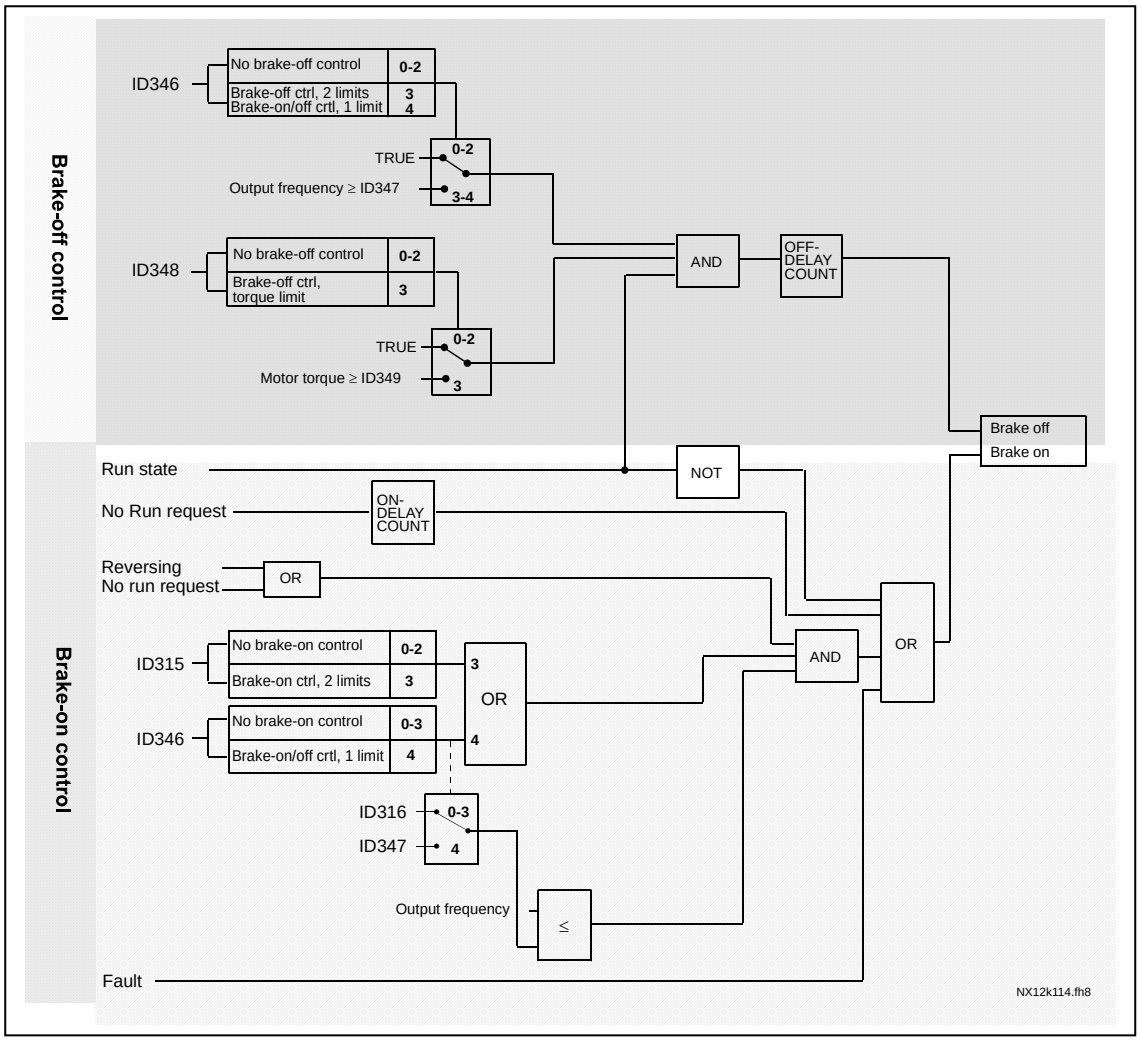

Figure 38. Brake control logic

9.1 Closed loop parameters (ID's 612 to 621)

Select the Closed loop control mode by setting value 3 or 4 for parameter ID600.
Closed loop control mode (see page 85) is used when enhanced performance near zero speed and better static speed accuracy with higher speeds are needed. Closed loop control mode is based on "rotor flux oriented current vector control". With this controlling principle, the phase currents are divided into a torque producing current portion and a magnetizing current portion. Thus, the squirrel cage induction machine can be controlled in a fashion of a separately excited DC motor.

Note: These parameters can be used with Vacon NXP drive only.

EXAMPLE:

Motor Control Mode = 3 (Closed loop speed control)

This is the usual operation mode when fast response times, high accuracy or controlled run at zero frequencies are needed. Encoder board should be connected to slot C of the control unit. Set the encoder P/R-parameter (P7.3.1.1). Run in open loop and check the encoder speed and direction (V7.3.2.2). Change the direction parameter (P7.3.1.2) or switch the phases of motor cables if necessary. Do not run if encoder speed is wrong. Program the no-load current to parameter ID612 and set parameter ID619 (Slip Adjust) to get the voltage slightly above the linear U/f-curve with the motor frequency at about 66% of the nominal motor frequency. The Motor Nominal Speed parameter (ID112) is critical. The Current Limit parameter (ID107) controls the available torque linearly in relative to motor nominal current.

9.2 Advanced Open Loop parameters (ID's 622 to 625, 632, 635)

Select the Advanced Open Loop control mode by setting value 5 or 6 for parameter ID600.
The Advanced Open Loop control mode finds similar implementations as the Closed Loop control mode above. However, the control accuracy of the Closed Loop control mode is higher than that of the Advanced Open Loop control mode.

EXAMPLE:

Motor Control Mode = 5 Frequency control (Advanced open loop) and 6 Speed control (Advanced open loop)

The motor is running at current vector control at low frequencies. At frequencies above the frequency limit, the motor is in frequency control. The default current value is 120% at zero frequency. Use linear U/f-curve (ID108). 120% starting torque should now be possible. Sometimes increasing the frequency limit (ID635) will improve the run. The Frequency limit is the critical point. Increase the zero frequency point to get enough current at frequency limit.

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9.3 Parameters of motor thermal protection (ID's 704 to 708):

General

The motor thermal protection is to protect the motor from overheating. The Vacon drive is capable of supplying higher than nominal current to the motor. If the load requires this high current there is a risk that the motor will be thermally overloaded. This is the case especially at low frequencies. At low frequencies the cooling effect of the motor is reduced as well as its capacity. If the motor is equipped with an external fan the load reduction at low speeds is small.
The motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor.
The motor thermal protection can be adjusted with parameters. The thermal current I_T specifies the load current above which the motor is overloaded. This current limit is a function of the output frequency.
The thermal stage of the motor can be monitored on the control keypad display. See Vacon NX User's Manual, Chapter 7.3.1.

CAUTION! The calculated model does not protect the motor if the airflow to the motor is reduced by blocked air intake grill.

9.4 Parameters of Stall protection (ID's 709 to 712):

General

The motor stall protection protects the motor from short time overload situations such as one caused by a stalled shaft. The reaction time of the stall protection can be set shorter than that of motor thermal protection. The stall state is defined with two parameters, ID710 (Stall current) and ID712 (Stall frequency limit). If the current is higher than the set limit and output frequency is lower than the set limit, the stall state is true. There is actually no real indication of the shaft rotation. Stall protection is a type of overcurrent protection.

9.5 Parameters of Underload protection (ID's 713 to 716):

General

The purpose of the motor underload protection is to ensure that there is load on the motor when the drive is running. If the motor loses its load there might be a problem in the process, e.g. a broken belt or a dry pump.
Motor underload protection can be adjusted by setting the underload curve with parameters ID714 (Field weakening area load) and ID715 (Zero frequency load), see below. The underload curve is a squared curve set between the zero frequency and the field weakening point. The protection is not active below 5Hz (the underload time counter is stopped).

The torque values for setting the underload curve are set in percentage which refers to the nominal torque of the motor. The motor's name plate data, parameter motor nominal current and the drive's nominal current I_H are used to find the scaling ratio for the internal torque value. If other than nominal motor is used with the drive, the accuracy of the torque calculation decreases.

9.6 Fieldbus control parameters (ID's 850 to 859)

The Fieldbus control parameters are used when the frequency or the speed reference comes from the fieldbus (Modbus, Profibus, DeviceNet etc.). With the Fieldbus Data Out Selection 1...8 you can monitor values from the fieldbus.

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10. DESCRIPTION OF PARAMETERS SPECIFIC FOR POSITION CONTROL APPLICATION

10.1 Digital inputs

General for all the inputs with functions related to the position controller is that the Position controller has to be enabled to accept them.

2.2.5.17 Calibrate sensor ID1520

Selection of digital input for the calibration sensor.
The calibration sensor is used during several calibration modes. Depends on which calibration mode is used. See chapter 6.2.7 and Figure 8. Position 1; Block diagram "Position mission control with fieldbus interface" for details.

2.2.5.18 Run calibration ID1521

Selection of digital input for start of the calibration cycle.

2.2.5.19 Run Home position ID1522

Selection of digital input for run to home position command. The home position is normally a start position for the positioning performed after the calibration cycle.

2.2.5.20 Jog forward ID1523

Selection of digital input for the Jog forward command. The motor runs forward with the Jog speed seleted by P2.8.9.1 as long as the input is high.
The function is limited by the max software limit P2.8.7.1

2.2.5.21 Jog reverse ID1524

Same as 2.2.5.20 but in reverse direction.
The function is limited by the min software limit P2.8.7.2

2.2.5.22 Jog forward increment ID1525

Selection of digital input for Jog forward increment command. The calibration cycle has to be done to enable this command. This position command uses the parameters in the G2.8.9 JOG. The command is not performed if the end position exceeds the max software limit P2.8.7.1.

2.2.5.23 Jog reverse increment ID1526

Same as 2.2.5.23 but in reverse direction. The command is not performed if the end position exceeds the min software limit P2.8.7.2.

2.2.5.24 Position controller enable ID1527

Selection of input for enabling the position controller. Position controller commands will be enabled with this input high. If the input is low the drive is in normal speed control mode. It is also possible to enable the position controller by P2.8.1.

2.2.5.25 Automatic enable ID1528

Selection of input for enabling the programmable automatic positioning sequence. The automatic sequence can also bee enabled by parameter P2.8.11.1
See chapter 6.2.10 Special function: Automatic cycle for details.

2.2.5.26 Trigger ID1529

Selection of trigger input for running to binary position command selected by P2.2.5.27 – P2.2.5.29 or for activating the automatic sequence.

2.2.5.27 Binary pos B0 ID1530

Input selection for binary position B0.

2.2.5.28 Binary pos B1 ID1531

Input selection for binary position B1.

2.2.5.29 Binary pos B2 ID1532

Input selection for binary position B2.

2.2.5.30 Calibration type 2 ID1533

Input selection for using the Calibration type 2 instead of Calibration type 1 according to P2.8.8.8.

2.2.5.31 Minimum end limit ID1534

Input selection for electromechanical switch placed in the minimum end of the positioning unit. Normally the software limit P2.8.7.2 takes care of the minimum limit of the positioning area. This input is an additional limit input. See chapter 6.2.4.1 Minimum limit stop for details.

2.2.5.32 Maximum end limit ID1535

Input selection for electromechanical switch placed in the max end of the positioning unit. Normally the software limit P2.8.7.1 takes care of the max limit of the positioning area. This input is an additional limit input. See chapter 6.2.4.2 Maximum limit stop for details.

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10.2 Protections

2.6.14 Position range error ID1560

Response to out of position range. The range is specified by parameters P2.8.7.1 and P2.8.7.2.

2.6.15 Dynamic error ID1561

Response to dynamic position error (during movement). The error threshold is specified by P2.8.7.7.

2.6.16 Static error ID1562

Response to static error (in standstill). The error threshold is specified by P2.8.7.5.

10.3 Position control

2.8.1 Position control enable ID1570

The position controller can be enabled by setting this parameter to 1.
By setting the parameter to 2 (enable from FB) the enable is taken care of by the Fieldbus master.

2.8.2 Encoder selection ID1571

Selection of encoder to be used for the position control loop.
Motor encoder is the same as the one used for the closed loop speed control.
In most cases motor encoder can be used for the position control loop.
Parameters 2.8.3 and 2.8.4 have to be set correctly when external encoder is used.

External encoder can be used to avoid drifting in case of slip between motor and the process. Parameters 2.8.3, 2.8.4, 2.8.7.11 and P2.8.7.12 have to be set correctly when external encoder is used.
Not all encoder boards support an external encoder. Support is provided, for example by the OPT-A7 board and OPT-BC.

2.8.3 Distance ID1572

Motor encoder distance in user units corresponding to the amount of turns given by P2.8.4. This allows the user to work only with engineering units for positioning. For example in millimetres or in degrees for a rotating table.
This parameter has to be set even if External encoder is selected by P2.8.2 for the positioning loop.

2.8.4 Turns ID1573

Motor encoder turns corresponding to the distance given by P2.8.3
This parameter has to be set even if External encoder is selected by P2.8.2 for the positioning loop.

2.8.5 Maximum speed ID1574

Maximum positioning speed in user units/s. This is the highest allowed positioning speed. All parameters for positioning speed are limited to this value.

2.8.6 Maximum acceleration ID1575

The maximum acceleration/deceleration allowed during positioning. This is the highest allowed acceleration during positioning. All parameters for positioning acceleration are limited to this value.

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10.4 Advanced functions

2.8.7.1. Max position ID1580

Maximum end of the positioning range in user units. This is a software range that limits the motion in the upper end. If for example a *Jog increment* command is requested that will result in an end position over this software maximum range the command will not be executed. *Jog forward* command will also stop on this range.

2.8.7.2 Min Position ID1581

Same as P2.8.7.1 but in the minimum end of positioning range.

2.8.7.3 Proportional gain ID1582

Proportional gain for the position loop

2.8.7.4 Target delta ID1583

Target delta for final position. The position controller will bring the axis to the position given from the actual position command +/- the value of this parameter.

2.8.7.5 Static error ID1584

Accepted static error (in standstill) in user unit. Response to this error can be selected by P2.6.16.

2.8.7.6 Settling time ID1585

Time for changing from dynamic to static error supervision at the end of the position mission.

2.8.7.7 Dynamic error ID1586

Accepted dynamic error (during movement) during positioning. Response to this error can be selected by P2.6.15.

2.8.7.8 Calibration on Home ID1587

Setting this parameter to 1 performs calibration cycle at every *Home* command. After calibration cycle is done the drive starts moving to the Home position.

2.8.7.9 Trig mode ID1588

Selection of level or pulse logic for trig commands from digital inputs.
See chapter 6.2.2 The control sequencer: commands for details.

2.8.7.10 Speed reference ID1589

With this parameter it is possible to select if the positioning speed reference is taken from parameters or from Analogue input 1 or Analogue input 2. The speed reference from analogue inputs is scaled from 0 to maximum positioning speed.
Note: Analogue speed reference is read before start mission (not updated during running)

2.8.7.11 Distance external encoder ID1576

Distance in user units corresponding to the amount of external CH2 encoder turns given by P2.8.7.12 This allows the user to work only with engineering units for positioning. For example in millimetres or in degrees for a rotating table.
This parameter has to be set correctly if external encoder is selected by P2.8.2
Option boards OPT-A7 and OPT-BC supports external encoder CH2.

2.8.7.12 Turns ID1577

Encoder turns corresponding to the distance given by P2.8.7.11
This parameter has to be set correctly if external encoder is selected by P2.8.2

10.5 Calibration Home

See chapter 6.2.5 for more detailed information about calibration.

2.8.8.1 Calibration type 1 ID1595

Selection of calibration mode to be used for calibration mode type 1.

2.8.8.2 Calibration speed ID1596

Speed used during calibration cycle.

2.8.8.3 Calibration high speed ID1597

High speed used during first phase of calibration modes 4 and 5.

2.8.8.4 Calibration preset ID1598

Preset absolute position assigned to the calibration point in user units.

2.8.8.5 Home speed ID1599

Speed used during the *Home* command running to the Home position.

2.8.8.6 Home acceleration ID1600

Acceleration/Deceleration used during *Home* command.

2.8.8.7 Home position ID1601

Absolute home position in user unit. The home position is often used as an initial position from where the normal operation starts.

2.8.8.8 Calibration type 2 ID1602

Selection of mode for calibration Type 2. This is an alternative calibration mode that can be selected by a programmable digital input with P2.2.5.30. This mode is normally not needed.

2.8.8.9 Maximum calibration travel ID1603

The maximum allowed travel distance in user units during the calibration cycle.

10.6 Jog

2.8.9.1 Jog speed ID1610

Speed in user unit used during *Jog* and *Jog increment* commands.

2.8.9.2 Jog acceleration ID1611

Acceleration/Deceleration used during *Jog* and *Jog increment* commands.

2.8.9.3 Jog increment distance ID1612

Incremental relative distance in user units used for *Jog increment* commands.

10.7 Positions

The absolute target position and the corresponding speed and acceleration is selected with programmable digital inputs with parameters 2.2.5.27 to 2.2.5.29. The drive starts running to the selected target position when the trigger input goes high. It is also possible to activate these positions from the automatic sequence.
If the speed and/or acceleration for Position 001 – Position 111 is set to 0 the same speed and/or acceleration as for Position 000 is used. See chapter 6.2.2.7 Go to Position.

2.8.10.1 000 Position ID1620

Absolute position in user unit for the position 000 selected by binary inputs P2.2.5.27 – P2.2.5.29.

2.8.10.2 000 Speed ID1621

Speed in user unit/s used during positioning.

2.8.10.3 000 Acceleration ID1622

Acceleration in user unit/s^2 used during positioning.

2.8.10.4 001 Position ID1623

Absolute position in user unit for the position 001 selected by binary inputs P2.2.5.27 – P2.2.5.29.

2.8.10.5 001 Speed ID1624

Speed in user unit/s used during positioning. If the speed is set to 0 (default) the same speed as for 000 speed is used.

2.8.10.6 001 Acceleration ID1625

Acceleration in user unit/s^2 used during positioning.
If the Acceleration is set to 0 (default) the same acceleration as for 000 Aceleration is used.

2.8.10.7-2.8.10.24 Position 010 – 111 parameters, ID1626-ID1643

Same settings as for Parameters 2.8.10.4 –P2.8.10.6.
See Table 32 in chapter 6.2.2.7 Go to Position.

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10.8 Automatic cycle

See chapter 6.2.10 Special function: Automatic cycle for details.

2.8.11.1 Position control mode ID1650

Selection of the position control mode. The automatic mode enables the automatic sequence. It is also possible to enable the automatic mode by digital input P2.2.5.25.

2.8.11.2 Enable manual commands ID1651

With this parameter enabled it is possible to activate manual position commands when the automatic mode is enabled by P2.8.11.1.

2.8.11.3 Command 1 ID1652

First command for the automatic sequence. Commands available are Position 000 to Position 111, incremental Jog forward, incremental Jog reverse, Home. The first command is always activated by trigger input P2.2.5.26.

2.8.11.4 Pause 1 ID1653

Dwell time before next command is performed.

2.8.11.5 Trig mode 1-2 ID1654

Selection of trig mode for next command. In the normal mode the next command will be performed when the trigger input goes high and the dwell time has expired. The trigger input is ignored if the dwell time has not expired.
In the automatic mode the next command will be performed after the dwell time has expired. If next command is *No command* (end) the sequence will start from beginning.

2.8.11.6 Command 2 ID1654

Second command. See P2.8.11.3.

2.8.11.7 Pause 2 ID1655

See parameter 2.8.11.4.

2.8.11.8 Trig mode 2-3 ID1656

See parameter 2.8.11.5.

2.8.11.9-2.8.11.20 ID1657-ID1669

Same settings as for corresponding parameters 2.8.11.6 – 2.8.11.8.

10.9 Fieldbus

P2.9.9 Command register ID1675

Selection of process data PD In 1- PD In 8 used for the command register for positioning commands from fieldbus.

P2.9.10 Speed ID1676

Selection of process data PD In 1- PD In 8 used for the speed register for positioning commands from fieldbus.

P2.9.11 Acceleration ID1677

Selection of process data PD In 1- PD In 8 used for the acceleration register for positioning commands from fieldbus.

P2.9.12 Position ID1678

Selection of process data PD In 1- PD In 8 used for the position register for positioning commands from fieldbus.

P2.9.13 Deceleration ID1679

Selection of process data PD In 1- PD In 8 used for the Deceleration register for positioning commands from fieldbus. If this is not used the deceleration time will be the same as that of acceleration.

P2.9.14 Torque reference ID1680

Selection of process data PD In 1- PD In 8 used for the Torque reference. This can be used for torque control mode with position control disabled.

P2.9.15 Free signal ID1681

Selection of process data PD In 1- PD In 8 used for the Free signal. This can be used for the current or torque limiting according to functionality of the Multipurpose application).

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10.10 SystemBus

P2.10.1 System bus mode ID1685

Selection of system bus mode in use.
The System Bus parameter must be set to 3 for the master or to 2 for the follower or left to 0 when not in use.

10.10.1 Master

P2.10.2.1 Master output ID1686

Selection of signal to be sent from master to follower drives.

10.10.2 Follower

P2.10.3.1 Reference multiplier ID1687

Multiplier for the reference received from the master. Allows scaling of the reference on the follower side.

P2.10.3.2 Reference divider ID1688

Divider for the reference received from the master. Allows scaling of the reference on the follower side

10.11 Jog teach

P3.5.1 Jog speed ID1610

Jog speed in user unit/s during *Jog* command.

P3.5.4 Teach position ID1696

After running to a certain position by *Jog* command the position can be copied to a target position selected by this parameter.

11. SPECIFIC FAULT CODES OF POSITION CONTROL APPLICATION

The Position Control Application includes other warnings and faults in addition to those described in the product's User's Manual. The fault codes, their causes and correcting actions are presented in Table 47 (W=warning, F= fault).

Code	Fault	Type	Stored in history fault	Possible causes	Correcting actions
60	Posit RangeErr	Program-mable	Yes	The position displace-ment during zero search exceeds ±32767.	Cycle power and repeat zero set-ting cycle
61	Dyn PositErr	Program-mable	Yes	Positioning dynamic error: positioning error exceeded the admitted limit value during the movement	Verify mechanical conditions, position control calibration, P2.8.5 Max speed, P2.8.6 Max acceleration, P2.8.7.7 Dynamic error limit
62	Stat PositErr	Program-mable	Yes	Positioning static error: position error exceeded the admitted static limit value	Verify the possible reasons for axis overriding the limit P2.8.7.5 Static error. If this fault occurred exactly at the end of positioning, increase the settling time P2.8.7.6
63	MinEnd Cam	W	No	The axis reached/stored minimum limit stop posi-tion (min. limit switch reached)	Move in positive direction or use *Jog forward* command. Alter-natively, if you need a manual recovering: set P2.8.7.11=0, switch off the inverter, perform manual movement, switch on the inverter and reset P2.8.7.11 to the original value
64	MaxEnd Cam	W	No	The axis reached/stored maximum limit stop posi-tion (max. limit switch reached)	Move in negative direction or use *Jog reverse* command. See code 63.

Table 47. APFIFF12 specific fault codes